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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. . . . L. W. MARSHALL, Manager
BOSTON OFFICE: 161 Devonshire Street . . . . . M. W. BARBER, Manager
EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

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TO PROMOTE PROPER ILLUMINATION.

A great deal of interest was aroused last week by the preliminary meeting of a number of business men and engineers interested in the subject of illumination. These men contemplate forming a society for promoting scientific study of this very important subject, and of advancing at the same time the art of applying it. That there is great need for much missionary work among those who have to do with the lighting of buildings would seem obvious to any one who has looked into the matter at all; yet there does seem to be a good deal of confusion, not only on the part of the public in general, but often with respect to engineers. Many seem to find it impossible to grasp the fact that a study of methods of securing a distribution of light in a room which will be best suited for the purposes for which the room is to be used is entirely different from the problem of delivering the necessary power to that room in the best and cheapest manner. It has been said by some that this work of illuminating belongs to the field of electrical engineering. Possibly this is so, but should it not also belong to the field of gas engineering or any other work which has to do with lighting? However, it makes no difference where we put it; the fact remains that there is here a large field which has long been neglected, the problems of which are large enough and complex enough to require the attention of specialists.

It seems to be a well-established fact that many bodily ailments are due to eye strain, and a good part of these can be traced to improper lighting of schools, offices and homes. Happily this condition will probably not last much longer, but to change matters and put them as they should be requires the concerted effort of those conversant with the problem.

It has been feared in some quarters that the formation of such a society would work to the detriment of the American Institute of Electrical Engineers. We can not see that there would be any such result. A similar fear was expressed in 1902, when the American Electrochemical Society was formed, but this society has in no way injured the older body, and can certainly claim the credit of having published a number of important papers and accomplished much good. The electrical engineer finds his work so intimately connected with other industries, simply because he is furnishing them with means for accomplishing desirable results, that he has formed the habit of claiming these other industries as part of his own. On sober thought, there are few who will not admit that in electrochemical problems the chief problem is really chemical: the electrical engineer merely furnishes the power for bringing about certain reactions. So it is with illumination: electrical energy is merely the agent for producing light. No matter how experienced the engineer may be in designing a plant and in laying out wires, he may be entirely ignorant of the best methods of securing the desired effect in the rooms. Certainly, unless he has devoted a good deal of study to the subject, his ideas are apt to be indefinite and his knowledge meagre.

Every one will admit that there is a great work to be done, not only in educating the layman, but in reducing the art of illumination to a scientific basis. The success with which the efforts of this society are met will depend largely upon the way in which it goes to work. It may be said that the interest shown by those who attended the meeting, the greater number of whom are widely known in the illuminating field, promises well.

THE INDEX FOR VOLUME FORTY-SEVEN.

This issue of the ELECTRICAL REVIEW contains the index for Vol. XLVII. No additional copies of the index will be distributed, and it is urged upon all recipients the importance of preserving this record. These pages form not only an index of the ELECTRICAL REVIEW, but of the important happenings in the electrical industries during the six months just closed. The record is one highly satisfactory to these industries, but, better still, the indication is that the coming year will be even more prosperous.

PERMUTATORS.

In a recent issue of the ELECTRICAL REVIEW a note was made of an exhibit at the Brussels Exposition of three electrical machines of a new type. These are known as permutators, and were constructed according to the Rougé and Fajet system. The scheme is an old one, but these seem to have been the first machines of this type which have been built for commercial application.

The idea of the permutator is to convert an alternating current into a direct current without resorting to a large rotating mass of iron and copper. The object is accomplished in the same way that an alternating current is converted into a direct current in a synchronous converter, with the exception that in the latter device an armature is revolved in a stationary field, while in the permutator a stationary winding is cut by a revolving field, and this revolving field is obtained by means of polyphase currents. An unfortunate feature of this arrangement requires that the brushes be revolved in order that they may keep in step with the moving field, in fact, this seems to be the main drawback to the device, for in other ways it possesses a number of rather important advantages.

Since the relative rotation of the winding and field is produced electromagnetically, and not mechanically, there is no need for mechanical clearance. The machine consists of a winding threaded through tunnels in a cylindrical iron core. A considerable depth of iron is left on each side of these tunnels, so as to complete the magnetic circuit. A commutator of the usual type is attached to the machine and tapped in in the ordinary way.

To secure synchronous rotation of the brushes, advantage is taken of the weak field which leaks across through the opening in the core. Within this opening is placed a ring-wound armature, short-circuited at a number of points so that it will start as an induction motor. Taps are taken off this winding to slip rings, and a direct current let in through them from the main brushes. This has the effect of pulling this small brush rotor into synchronism as it approaches that speed.

The advantages claimed for this device are the following: since the only rotating part is the brush rotor, which is small, there is no difficulty whatever in starting it. The machine can be brought up to full speed in a few seconds. Moreover, due to the method of construction, it automatically brings itself into step, though there is an uncertainty regarding the polarity of the brushes. Since there is no air-gap in the device, the magnetizing current and the leakage should be small, and this would give a high power-factor, which, however, must be offset somewhat by the fact that the entire magnetizing component of current must be furnished by the line. The fact that there is no heavy moving body should reduce the danger of hunting, and the machine may be built for any frequency whatever. There would seem, however, to be some danger of hunting of the brush rotor, which might cause bad sparking. It is said that the construction of the device enables the weight per kilowatt to be made considerably smaller than that of a rotary converter; and as the only moving part is the brush system, a vertical construction has been adopted, which reduces the floor space required. As against these advantages there is the disadvantage of rotating brushes, and the inability to adjust the brushes and the power-factor during operation. The power-factor may, however, be varied by shifting the relative positions of brushes and brush rotor before starting.

One of these machines was tested recently by Dr. C. V. Drysdale, of Northampton Institute, England, with favorable results. The machine is rated at ten kilowatts, and at full load has an efficiency of seventy-five per cent and a power-factor of 0.9. Tests of a 150-kilowatt machine by the inventors showed an efficiency of ninety-six per cent and a power-factor of 0.93. One unfortunate feature found by Dr. Drysdale in his test was the unsuitability of the machine for charging storage batteries. He found that when used for this purpose it sparked considerably, and that it seemed to deliver an irregular current.

To reduce sparking of the machine an ingenious arrangement has been adopted by the inventors. The commutator is constructed with a double number of segments, the alternate ones being connected to the coils of the machine, the remaining ones being connected to an adjacent segment through a small commutating resistance.

As noted above, the chief objection to this machine seems to be the rotating brushes. Moreover, provision must be made for maintaining constant brush pressure; but this is not difficult. There is, nevertheless, a feeling that rotating brushes are mechanically bad, and this prejudice, although it may be greater than the conditions justify, is still apt to hinder considerably the general introduction of this interesting device.

THE PREVENTION OF SEASICKNESS.

It was stated recently in a metropolitan newspaper that on a transatlantic liner which had just come across from Europe were a number of representatives of a German company, who brought along with them "several electrical non-vibrating chairs which were designed to counteract or prevent seasickness." Just what electricity has to do with these chairs was not explained. Perhaps they are constructed according to the arrangement known by physicists as the Julius suspension, which is employed for hanging delicate apparatus so as to prevent disturbances due to vibrations of the building. In this respect the chairs seem to have been successful, as it is stated that no bad effects were experienced while the passengers were seated in them. Unfortunately, however, as soon as the occupant vacated his chair, he felt the effects of the vessel and warnings of coming trouble. For this reason the new wonder can not be considered altogether satisfactory.

Considering the matter for a moment, it would seem that the designers of this remarkable piece of apparatus were proceeding along lines directly opposed to those which they should follow. If the passenger could be placed in one of these non-vibrating chairs and remain seated there during the entire voyage, he would possibly avoid the pangs of seasickness; but this being out of the question, he receives a setback every time he sits in the chair, since he must reaccommodate himself to the motion of the vessel whenever he gets up. What the

inventors should do would be to make a chair which would take a prospective voyager and shake him up so thoroughly that he would be over and through with his seasickness in five or ten minutes. A chair of this kind, we believe, was shown at the Louisiana Purchase Exposition, though not intended just for this purpose. Or the steamship companies might arrange to give intending passengers a preliminary treatment extending over several days, so that they can accommodate their systems gradually to living on a moving vessel. Taking a week's training on a model ship, so as to have oneself pretty thoroughly shaken up before starting on the trip, should make one fairly immune from the discomforts of ocean travel.

Fortunately, however, there seems to be no great need for either method of treatment, for with the increasing length and size of ocean steamers, the pitching and rolling have been reduced, so that seasickness is now the exception rather than the rule. This reminds one that the new Cunard steamer, Carmania, was hailed as a vessel upon which one might sail without much risk of seasickness, this immunity being attributed to the turbine engine. The turbines, however, do not prevent the motion of the ship as a whole, they merely do away, to a large extent, with the vibration which is caused by the reciprocating engine, and which, while disagreeable, is not likely to produce seasickness.

ATOMIC DISINTEGRATION AND COMMERCIAL STANDARDS.

An interesting discussion is being carried on in *Nature* (London) regarding the possibility of the transmutation of elements one into another. This was started by Mr. Donald Murray, who called attention to the invariable occurrence of silver in a lead mine, or of lead in silver. A lead mine is a silver mine the world over. This fact seems to be more than a coincidence, and leads to the question whether there is not some such relation between these two metals as is believed to exist between uranium and radium.

Mr. Murray's question leads Mr. Frederick Soddy to point out that the history of gold mining has been the same through all times. There has never been a discovery of gold in such large quantities, and so easily obtainable, as to affect the price of this material as a standard of value. This seems to Mr. Soddy to be more than a coincidence. There must be some reason why gold is always found in small quantities and scattered. Is it not possible that it results from the disintegration of some other element and is itself gradually changing into a third? Should this be the case, the amount of gold existing at any time would be determined directly by the ratio of the two changes.

Mr. Soddy has even attempted to detect some such change, but so far unsuccessfully. He has, however, found that helium occurred in all samples of platinum which he was able to secure. Helium was found in small gold samples, but in others was not detectable. The work is difficult, since the changes appear to be exceedingly slow—so slow that the lifetime of one investigator would appear to be too short for the work. He therefore suggests that the problem be made a national one, and carried on by successive investigators through a long period. The amount of gold required would be too great for one experimenter to obtain, but the treasure vaults of all governments have now stored away large quantities of this material which possibly is undergoing the very change which is to be sought. Should such a change be found, the effect would be far-reaching. "Not only," says Mr. Soddy, "is there to be considered the effect such results must exert on the whole trend of philosophic thought, but certain definite economic problems would be solved; for example, the proof of the disintegration of gold would reduce the doctrine of bimetallism and the theory of currency to a branch of physical science." This would be an unexpected result of Becquerel's observation.

NON-CONDUCTING CARBON.

In an address delivered recently before the Birmingham section of the Institution of Electrical Engineers, of Great Britain, Mr. R. Threlfall discussed some electro and electrothermal problems which have been receiving a good deal of attention of late. He dealt with a wide variety of topics, but one of the most interest was that dealing with the allotropic states of carbon. This is interesting, not because there is a faint possibility of the manufacture of artificial diamonds, but because of the scientific value of investigations in this field.

Mr. Threlfall called attention to some important work done three years ago by Dr. A. Ludwig. Ludwig, by heating carbon in an electric arc to a high temperature, subjecting it to a high pressure, and then cooling it as rapidly as possible, secured a sort of vitreous carbon, which, while it could not be called diamond, was hard and non-conducting. The experiment is difficult to perform. Carbon rods were placed in contact and then surrounded with an atmosphere of hydrogen at a pressure of about ten tons per square inch, and a current passed through. It was found difficult to form an arc under these conditions with carbon, although with metal there was no trouble. There was also a peculiar phenomenon: the current, after being started, would flow for a short time, then stop, and after a few seconds again start, the interruptions going on repeatedly. To obtain any crystalline formation it was necessary to cool the heated carbon suddenly, which was done by directing a stream of water, under high pressure, against the hot material. The material secured in this way seemed to be a sort of black carbon glass. Since the hot material was cooled very rapidly, there was no opportunity for large crystals to be formed.

Mr. Threlfall compares the changes which took place here with those which are known to take place in the case of sulphur. Large octahedral crystals of sulphur have never been made artificially, but they do occur in nature. These might be formed by raising the temperature and the pressure to points above those at which the monoclinic crystals are formed, and then allowing it to cool at constant pressure. The cooling should be carried out slowly to give opportunity for large crystals to form. If these experiments were successful, there would be sufficient encouragement to try the same method with carbon. Ludwig carried his pressures to only twenty tons per square inch, yet with materials now obtainable it should be possible to carry the pressure to fifty or even seventy-five tons. This great increase in the range of the experiment should be productive of highly important and interesting results.

THE ELECTRICAL NATURE OF MATTER AND RADIOACTIVITY.

BY HARRY C. JONES.

CHAPTER XIV.—(*Concluded*).

INDUCED RADIOACTIVITY DUE TO THE DEPOSIT OF RADIOACTIVE MATTER.

The relation between induced radioactivity and the emanation from radioactive substances, has been developed, and it has been shown that the latter is the cause of the former. This, however, but raises the question, how does the emanation render objects exposed to it temporarily radioactive? To answer this question we must study closely the property of induced radioactivity. If a thorium or radium salt is placed in a closed vessel, all objects in the same vessel whatever their nature, are rendered radioactive. If, however, a negative electrode is introduced into the vessel, *all* the excited radioactivity is confined to this electrode. A convenient method of performing this experiment is to introduce the radioactive salt into a metal vessel which is connected with the positive pole of a battery. A metal wire is introduced into the middle of the vessel, passing through an insulating stopper. This wire is made the *negative pole* of the battery. Under these conditions, the wire is the *only object* in the vessel that is rendered radioactive, and its induced radioactivity may, according to Rutherford, become many thousand times greater than the natural activity of the thorium salt which induced the activity in the negative electrode.

It is difficult to account for this fact, together with the fact that the emanation is the cause of all the induced radioactivity, on any other ground than that the *induced radioactivity is produced by a deposit of radioactive matter upon objects placed in the neighborhood of naturally radioactive substances.*

This theory would explain the above and correlated facts.

To hit upon a theory that explains all the known facts and predicts new ones is one thing, but to show that this is the only suggestion that will account for these facts is quite a different matter. Further, the value of a theory or generalization is to be tested rather by its ability to predict new and undiscovered facts, and then have the predictions verified by experiments, than simply to account for what is already known.

If the induced radioactivity is due to the deposition of radioactive matter upon non-radioactive substances, then this matter would have definite properties. We ought to be able to remove it mechanically from the object upon which it was deposited, etc.

We shall now see that the cause of the induced radioactivity can be removed mechanically and otherwise from objects upon which it has been deposited, and that its properties have already been studied in some detail.

PROPERTIES OF THE RADIOACTIVE MATTER DEPOSITED BY THE EMANATION FROM RADIOACTIVE SUBSTANCES.

The properties of the active matter deposited by the emanation from thorium have been studied by von Lerch. The active matter was allowed to deposit upon platinum, and its solubility in different solvents then determined by measuring the decrease in the induced radioactivity of the platinum. This active matter was insoluble in such organic solvents as ether and alcohol. It was dissolved by hydrochloric acid, and the solution was radioactive. The radioactivity of this solution was greatly diminished by causing a precipitate to be thrown down from it. Thus, if barium chloride was added to the hydrochloric acid solution, and the barium thrown down as sulphate, most of the radioactive matter was carried down by the precipitate which was strongly radioactive.

If a piece of magnesium was exposed to the emanation from thorium until it became highly radioactive, and then dissolved in hydrochloric acid, the magnesium when precipitated as carbonate or phosphate carried down with it the radioactive matter. Most of our knowledge of this radioactive matter, however, we owe to the splendid work of Rutherford. He showed that this matter is only very slightly soluble in water or nitric acid. It is, however, readily dissolved by hydrochloric, hydrofluoric or sulphuric acid. When the solution in acids was evaporated, the active matter was left behind in the residue. The *rate* at which the active matter decayed was unaffected either by throwing it down with a precipitate, or by dissolving it in acids.

Rutherford showed also that the active matter can be removed from an object upon which it has been deposited purely mechanically. If a piece of platinum wire has been rendered highly radioactive by exposing it for some time to the emanation from thorium, and is then rubbed with a piece of sand-paper, nearly all of the radioactive matter can be removed from the platinum. The sand-paper, in turn, becomes radioactive.

We know less about the properties of the radioactive matter deposited by the emanation from radium, since, as we have seen, this *decays* much more rapidly than the deposits from the emanation given off by salts of thorium. It has, however, been shown that the radioactive matter from radium differs at least in its solubility from the radioactive matter deposited from thorium.

EMANATION X.

The above facts suffice to show that induced radioactivity is caused by the *deposit upon the non-radioactive substance of a radioactive form of matter,* which can be removed from the substance either mechanically or chemically, and which has definite chemical and physical properties of its own. This radioactive deposit has been termed by Rutherford *emanation* X. Another name was given to it later, as we shall see. The amount of such radioactive matter that is deposited is *very small.* This is what we should expect, since we have learned that the amount of the emanation itself, given off by the most active substances—radium and actininum, is almost infinitesimal. Rutherford points out that no matter how long a piece of metal is exposed to the emanation, the amount of radioactive matter deposited is *too small to be detected, even with the most refined chemical balance.*

Here is then another remarkable fact added to that long list of remarkable facts that have been brought to light as the result of the discovery and study of radioactive phenomena. Certain radioactive substances give off almost an infinitesimal quantity of a kind of matter which is analogous to a gas, and which has properties literally undreamed of by men of science. This minute quantity of substance manifests most of the radioactivity shown by the natural radioactive substance from which it came. It produces a chemical element helium as one of its decomposition products, and perhaps most remarkable of all is the *amount of energy* that it can give out in the form of heat. It was justly regarded as one of the most surprising facts known to science, when the Curies discovered that salts of radium themselves gave out heat energy in such quantity that a piece of radium would melt its own weight of ice every hour.

This discovery dwindles into insignificance in comparison with that made by Rutherford, that about three-fourths of this heat comes from something that exists in the radium salt in relatively infinitesimal quantity, and which is continu-

ally decaying and being manufactured by the radium—the *emanation*. It is perhaps no great cause for wonder that such a discovery should have raised questions even in connection with such a fundamental generalization as that of the conservation of energy.

We now find that the emanation in decaying yields a product, which must exist in still smaller quantity than the emanation itself, and which has the power of rendering inactive substances on which it is deposited, *strongly radioactive*. This induced or excited radioactivity as it is termed, also undergoes decay, showing that the radioactive matter deposited by the emanation undergoes still further changes.

Some of these changes have already been studied by Rutherford.

FACTS THAT MUST BE TAKEN INTO ACCOUNT IN DEALING WITH THE DECAY OF INDUCED OR EXCITED RADIOACTIVITY.

In studying the transformations that are undergone by the radioactive matter deposited by the emanation, let us first turn to the facts that have been brought to light by Rutherford, and clearly stated by him in his Bakerian lecture before the Royal Society.

To simplify the matter, we shall deal with the transformations in detail only in the case of radium. The induced radioactivity produced by radium undergoes decay, and at the same time gives off α, β, and γ particles. If we measure the decay of the excited radioactivity by means of the α rays, we obtain a different result from that arrived at if we measure the decay by means of the β or γ rays. In measuring the decay of the induced radioactivity, a rod was exposed to the emanation from the radium salt and became radioactive. If the rate of decay of the induced radioactivity was to be measured by means of the α rays, the rod was placed in the centre of the testing cylinder, a saturation voltage used, and the rate of leak through the gas between the walls of the cylinder and the rod measured. The current passed through the gas due to its partial ionization by the radioactive matter on the rod, and was measured by means of an electrometer.

If the decay in the excited radioactivity was measured by means of the β rays, an electroscope was employed. The rod was covered with a metal screen of sufficient thickness to cut off all the α rays, and was placed just beneath the electroscope.

When the decay of the induced radioactivity was to be measured by means of the γ rays, the electroscope was placed on a thick piece of lead, and the rod beneath the sheet of lead. The lead plate would cut off both the α and β rays, and allow only the γ rays to pass.

The results that were obtained in the case of radium are the following: If the rod was exposed only a very short time, say a minute, to the radium emanation, the activity as measured by the α radiation *decreased at first very rapidly*, dropping to about one-half of its initial value in three minutes, and to about one-tenth of its initial value in fifteen minutes. Then, during a period of about half an hour there was very little decrease in the radioactivity, and after three or four hours the activity dropped to half-value in twenty-eight minutes. If the rod had been exposed for a long time to the radium emanation, some differences in the rate of decay manifested themselves. The induced activity did not drop off so rapidly at first, requiring about fifteen minutes to reach half-value. The decay then progressed slowly, finally becoming almost zero, after about four hours dropping, however, to half-value in twenty-eight minutes.

If the rate of the decay of the induced activity is measured by the *β rays*, quite different results are obtained. If the rod is exposed to the emanation only a very short time, say one minute, the activity is at first small, but rapidly increases, passing through a maximum in about a half-hour. After the maximum is reached the activity gradually decreases, after several hours falling, however, to half-value in twenty-eight minutes.

If the rod has been exposed to the radium emanation for a long time, the activity as measured by the β radiations decays very differently. It does not increase at first and pass through a maximum, but decreases very gradually with time from the very first. In this case, where the rod has suffered exposure to the emanation for a considerable time, the decay as measured by the β radiation after the first ten or fifteen minutes resembles the decay as measured by the α radiation. It will be remembered that the decay as measured by the α radiation diminishes very rapidly for the first fifteen minutes. This is not the case when the rate of decay is measured by the β radiation.

When the rate of decay is measured by the γ radiation, results are found which are exactly similar to those obtained with the β radiations. This is just what we would expect from the relation that we have already learned exists between the β and γ rays.

INTERPRETATION OF THE ABOVE FACTS.

The following interpretation of the above facts has been given by Rutherford: The rapid initial decrease in the radioactivity, as measured by the α rays, is due to a change taking place that gives rise to the α rays. This transformation takes place to the extent of fifty per cent in about three minutes. If we examine the activity as measured by the β rays during this period, we find the absence of any drop during this initial time. This shows that this first transformation, which takes place largely during the first three minutes, does not give out β rays, otherwise the activity as measured by the β rays should decrease rapidly during this period.

We will term the active matter deposited by the emanation, not emanation X, as we have hitherto done, but *radium A*. Radium A gives out α particles only, and quickly undergoes a transformation into *Radium B*.

A study of the rate of decay as measured by α, β and γ rays, leads to the conclusion that a second transformation goes on, in which no radiation is given out. This second change, in which radium B passes over into *Radium C*, takes place to the extent of about fifty per cent in twenty minutes.

We have seen that after radium A has been removed several hours from the emanation, the decay of the activity as measured by the α, β or γ rays is very rapid, falling to half-value in twenty-eight minutes. Since the same result is obtained, regardless of the nature of the radiation employed, we must conclude that the change that is going on during this period must be accompanied by all three kinds of radiations, α, β and γ. We thus have radium C passing over into *radium D*, giving out α, β, and γ radiations during the transformation.

Rutherford thinks he has detected a still further transformation of radium D into *radium E*, β rays being given out. Radium E gives off α particles and passes over into something the nature of which is as yet entirely unknown. Whether further transformations exist, or can be followed, remains to be seen.

In a manner similar to the above, it has been made highly probable that the emanation from thorium gives rise to a radioactive deposit—thorium A, which undergoes two transformations, at least, giving thorium B and thorium C.

Uranium does not yield an emanation, but uranium X apparently breaks down at once into the final product.

Actinium yields an emanation, which

decomposes in at least three stages, giving actinium A, B and C.

The chemical nature of such products as those just described is entirely unknown, and will remain so until they can be obtained in sufficient quantity to be studied at least by the more refined chemical methods.

CHAPTER XV.

Production of Radioactive Matter.

CONTINUOUS FORMATION OF RADIOACTIVE MATTER IN URANIUM.

We have learned that thorium and radium from which the emanation has been removed, have lost most of their radioactivity. We have seen that the emanation loses its activity, but what is more important in the present connection, the de-emanated substance *regains its radioactivity on standing.* Further, when all the emanation has been driven out from a radioactive substance and the de-emanated substance has regained its radioactivity on standing for a time, more of the emanation can then be removed from this same substance.

These facts can best be interpreted by assuming that some change is continuously going on in the radioactive substances, *which gives rise to the emanation,* and restores the radioactivity.

In connection with the changes taking place in radioactive substances a most important discovery was made in 1900 by Sir William Crookes. He found that a very active constituent could be separated from uranium by chemical means, and that the remaining uranium was not radioactive.

If to a solution of a uranium salt a solution of ammonium carbonate is added, the uranium is precipitated. If an excess of the ammonium carbonate is added the precipitate dissolves in this reagent. There, however, remains a small residue that does *not* dissolve when an excess of ammonium carbonate is added. This residue can readily be filtered off from the solution, and was found to be highly radioactive, as compared with uranium itself. This residue was called by Crookes, *uranium X* and written UrX.

RECOVERY OF ACTIVITY BY URANIUM, AND DECAY OF ACTIVITY IN URANIUM X.

The uranium from which the uranium X was thus separated, was left less radioactive. If this uranium was laid aside for a time, it was found to *regain its original radioactivity* again.

The uranium X, on the other hand, *gradually became less active,* until after about twenty-two days its radioactivity was only half as intense as when it was first precipitated.

The rate at which uranium X loses its activity has been carefully studied, and the curve expressing the decay of the activity with time has been plotted. Similarly, the curve expressing the rate at which the uranium, from which the uranium X has been separated, regains its activity, has been plotted. These curves show that the uranium X loses its radioactivity *just as rapidly* as the uranium *regains* its activity. In a word, that in ordinary uranium we have *uranium X undergoing decay at just the same rate that it is being formed,* and the condition that exists is one of equilibrium between these two opposite processes.

The *rate* at which uranium *recovers* its radioactivity has been found to be *entirely independent of the conditions* to which it is subjected.

The *rate* at which uranium X *loses* its activity has also been found to be ***entirely*** *independent of all conditions both physical and chemical.* It is unaffected by the state of aggregation of the radioactive matter, by the presence of any chemical reagent, and what is more surprising, by the temperature to which it is subjected. As Rutherford points out, such processes taking place in radioactive substances are, thus, fundamentally different from any known chemical reactions, which are affected by changes in many conditions, and especially by changes in temperature.

We can now see why the radioactivity of uranium is constant. It represents, as mentioned above, an equilibrium between the two opposite processes—the continual production of the radioactive uranium X at a *constant rate,* unaffected by any change of conditions; and the continual decay of the activity of the uranium X at a constant rate, also independent of all conditions. As both of these processes go on at a constant rate, the equilibrium between the two represents a condition where there is a constant amount of uranium X in the uranium, and, hence, a constant radioactivity.

RADIATION FROM URANIUM X.

One other matter of importance and interest should be mentioned before leaving the discussion of radium X.

One peculiarity in connection with the radioactivity of uranium has already been pointed out. It does not give off an emanation.

The radiation from uranium X consists of β rays. These, as will be remembered, consist of negative charges of electricity shot off with a velocity nearly equal to that of light, and contain no matter whatsoever. In a word, they are cathode rays. The radiation from uranium X contains then, no matter, but only electrical energy.

The recognition of this fact is a matter of the very greatest importance in connection with the study of the relations between uranium and uranium X. It will be remembered that the β particles affect a photographic plate to a much greater extent than the α particles.

In order to determine the loss of activity in the uranium from which uranium X has been separated, we must use the photographic method. We must also employ this same method for measuring the activity of uranium X.

The electrical method would give entirely erroneous results when applied to this problem, as Rutherford and Soddy pointed out. In the first place, it would not detect at all the true intensity of the radiation from uranium X, since, as we have seen, the β rays have very little power to ionize a gas. Again, it would show about the same activity in uranium after uranium X had been separated as before the separation had been effected, since uranium continues to give off α particles after it is freed from uranium X to just about the same extent as before. And we have learned that it is the α particles that have most of the power to ionize a gas—the β and γ rays together having this power only to one per cent of that possessed by the α particles.

The facts just pointed out in connection with the radiations given off by uranium, on the one hand, and uranium X, on the other, are of prime importance in determining the radioactive products that are formed from uranium. In addition to uranium X which gives off β particles, being formed from uranium, there must also be formed *another radioactive product* which sends off α particles.

As we have just seen, uranium X or the active constituent which gives out β rays, has been separated from uranium; but the other active product which gives out the α radiations has not yet been separated from salts of uranium by any means that have been employed.

(To be continued.)

New York Electrical Society.

The revised and amended constitution and by-laws and list of members of the New York Electrical Society is ready for distribution. The society has prepared a notable list of subjects for meetings for the season of 1905-1906. These include the following papers: "Electrical Reactions of Gases," Peter Cooper Hewitt; "Ether Telegraphy," William Marconi; "News, Newspapers and the Telegraphic Art," Melville E. Stone; "Two Thousand Years of the Steam Turbine," C. G. Curtis; "The Place of the Electric Vehicle in Automobilism," Robert McAllister Lloyd; "The Single-Phase Railway," C. F. Scott.

North Mountain Power Company's Plant.

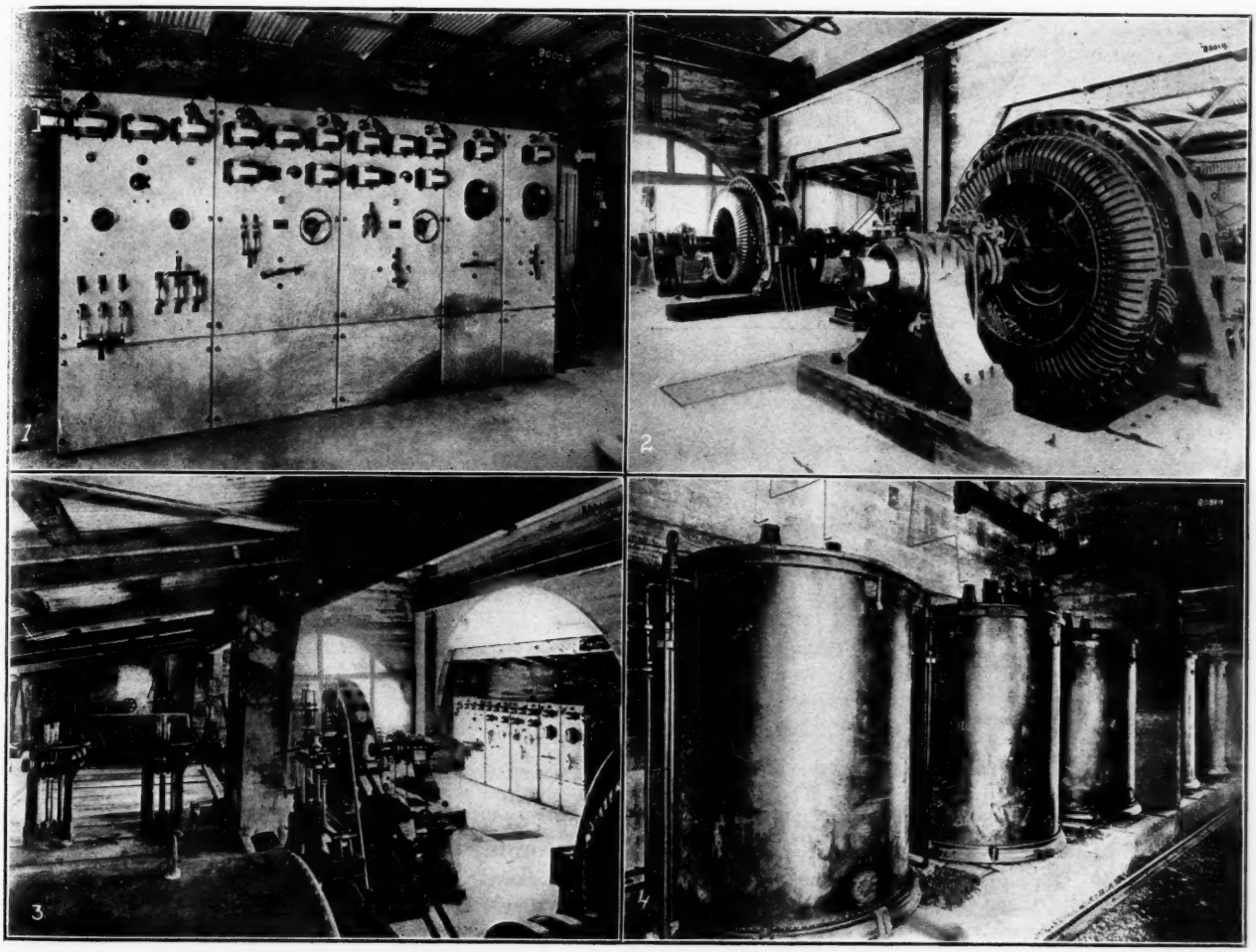
An Interesting Installation in Trinity County, California.

AMONG the power-transmission systems of the Pacific coast, that have been constructed with an eye to the future rather than the present needs of the communities which they serve, one of the most interesting is that of the North Mountain Power Company.

This plant is located in the central part of Trinity county, California, two miles below the town of Junction City, where Cañon creek, from which the water used for power is obtained, flows into the Trinity river.

Weaverville, the county seat, is twelve miles distant by road. The nearest railroad point is Redding on the "Shasta Route" of the Southern Pacific Railroad. Humboldt bay, on the Pacific ocean, with Eureka, the chief coast city of northern California, lies almost due west, distant fifty-nine miles in a straight line.

The altitude of the plant is about 1,400 feet. All material, cement and machinery were hauled in over fifty miles of the severest mountain roads, across three distinct divides or summits, viz.: Trinity mountain, Brown's mountain and Oregon mountain. It required eighteen to twenty animals to pull each of the larger pieces, weighing 18,000 pounds, up the grades, and when mud was encountered it was necessary to hitch eighteen animals to the fall of a block and tackle fitted with steel cables. Despite these difficulties, however, no mishap occurred to any of the machinery.



NORTH MOUNTAIN POWER COMPANY, TRINITY, CAL. 1—SWITCHBOARD IN POWER-HOUSE. 2—TWO 750-KILOWATT BULLOCK ALTERNATORS. 3—WATER-WHEEL HOUSINGS, GENERATORS AND SWITCHBOARD. 4—OIL-FILLED, WATER-COOLED, 300 K. V. A. BULLOCK TRANSFORMERS IN TRANSFORMER HOUSE.

WATERSHED.

The water used at the plant is diverted from Cañon creek, which has a drainage area of fifty-two square miles above the diverting dam. The upper part of the basin is a rugged, glaciated granite country, extending up to an altitude of from 9,000 to 10,000 feet above sea level, where some snow remains throughout the year. The higher parts of this basin are in the nature of an immense amphitheatre, lying on a flank of Thomson peak, which is a characteristic feature of all elevated glaciated topography. And, as is so often the case, the converging and descending glaciers have scooped out immense holes with almost perpendicular sides, which now form the beds of two lakes. These have been utilized as storage reservoirs.

Part of the watershed is heavily timbered, and lies within the boundaries of a government forest reserve. This will ensure the preservation of the forests, which are so effective in steadying the run-off.

The average annual rainfall for the last thirty-three years at Weaverville, twelve miles from the plant, has been 42.50 inches. At the higher levels of the watershed the precipitation is much greater,

but no records are available for that region, because the country is absolutely uninhabited and without even trails, except for the one to the above-mentioned lakes.

DITCH SYSTEM.

The dam is small, and serves merely for diverting the water. It is of the usual rock-filled crib form, which has been the type used for many years in mining operations on the Pacific coast.

The ditch system consists of alternating sections of ditch, flumes and one tunnel. Part of the ditch is cut in solid rock, but the most of it is dug in the side-hill soil, which stands well and puddles well.

The flumes are nineteen in number and vary in length from thirty to 1,200 feet. Those immediately below the dam are laid upon a solid bedrock bench and equipped with adequate spill-ways, waste-gates and sand-boxes. The total length of the flumes is 5,250 feet.

A tunnel 1,821 feet long has been driven to replace a temporary flume which was unavoidably built upon treacherous, sliding ground. This tunnel is heavily timbered throughout its entire length, and tightly lagged, except where the rock is unusually hard. The dimensions of the main tunnel are four feet nine inches by five feet ten inches in the clear. The total length of the ditch, flumes and tunnel is seven and one-quarter miles. The average grade of all is 0.00184, or 9.73 feet per mile. The ditch is provided with waste-gates and sand-boxes at suitable locations. The capacity of the ditch is eighty cubic feet per second, which is sufficient to operate at full load three units like the two which are now installed.

Near its lower end the ditch passes through a gap in the narrow ridge separating Cañon creek from Trinity river, and terminates in a forebay on the river side of the divide. Thus is secured a head due not only to the fall in Cañon creek in the seven miles through which the creek and ditch parallel each other, but also to the additional fall in a further course of two miles to the creek's junction with the Trinity river, and to the added fall in two miles of the river's course between the junction and the plant.

A telephone line extends from the power-house along the entire course of the ditch to the head dam. Instruments are placed in the station, the forebay tender's cabin, the head-gate tender's house, and at several other points along the line. Portable telephones can be readily connected at any point, and, as a result, any place along the ditch can have prompt communication with the power-house.

The forebay is excavated out of the solid rock of the hillside, ten feet deep, fourteen feet wide and sixty feet long. The ditch is provided with a gate at its entrance to the forebay, and the latter contains a gate and grizzly at the intake of each of the two penstocks. Provision has been made for a third penstock when a third unit shall become necessary in the plant. Suitable trash-racks are provided just above the forebay.

THE PENSTOCKS.

The penstocks, two in number, are each 1,165 feet long. Under a total head of 604 feet there is an effective head of 600 feet, or working pressure of 260 pounds per square inch.

There is one complete independent penstock for each of the two units. Each consists of a line of thirty-six-inch and twenty-eight-inch, and at the lower end two lines of eighteen-inch, all riveted steel pipe of various gauges, according to its position in the line. At the Y's or points where the single twenty-eight-inch pipe branches into two eighteen-inch lines, the penstocks are enclosed and anchored in a massive block of masonry laid up with imported Portland cement mortar. At their lower ends, just before entering the power-house, they are secured by a similar form of construction, and at various points they are held by bands and anchor bolts leaded and sulphured into the bedrock. Throughout their entire length they are laid in trenches and covered by back-filling, except at their lower ends where the profile of the hill is such that it was best to lay each in a separate tunnel. After completing and testing the penstocks, the tunnels were walled up and back-filled.

The penstocks are each provided with an eighteen-inch stand-pipe just outside the forebay walls to allow air to enter when the forebay gates are closed, and thus prevent collapse of the pipe. They are also provided with air-valves and manholes at suitable points.

BUILDINGS.

The plant proper consists of (1) the power-house, (2) the transformer house and (3) the high-tension switchhouse. In addition there are (4) the shop, (5) the operator's dwelling and (6) the stable. At the forebay is the forebay tender's cabin and at the dam is a house for the tender of the head-gates.

POWER-HOUSE.

Each of the two hydraulic units consists of a pair of forty-four-inch Pelton wheels under one sheet steel housing, provided with ring-oiling, self-aligning bearings, coupled to the generator through flexible leather link couplings. The nozzles are of the deflecting type. With the largest tips in service the wheels are capable of driving the generators at twenty-five per cent overload.

The wheels are controlled by type "P" Lombard governors, using oil. The pressure and vacuum are maintained by oil pumps, belt-driven from the wheel shafts. The governors are not fitted with any form of switchboard speed control, but a single operator has no difficulty in synchronizing a generator under the load conditions which exist in the plant.

The tail-race is six and one-half feet wide and excavated for 280 feet through bedrock to the Trinity river.

The generators, two in number, are of the Bullock type, furnished by Allis-Chalmers Company, of Milwaukee, they being three-phase, 750-kilowatt, 500 revolutions per minute, 2,200 volts, twenty-five cycles, revolving field, six-pole.

Two Bullock exciters, 125 volts, forty-five kilowatts, 900 revolutions per minute, are driven by belts from the generators. The switchboards are of marble and have Wagner instruments.

The power-house, thirty-six by fifty-one feet, is built of concrete made up with sand and gravel taken from the river bars a few rods from the site of the plant, and with imported Portland cement. A special bay or alcove has been provided to give ample space behind the switchboard. The roof is of corrugated iron supported on steel trusses.

A "Cyclops" hand-operated crane spans the main part of the building and is fitted with a 20,000 pound "Triplex" block. This easily handles the heaviest piece of machinery.

The leads between the generators, exciters and switchboard are lead-covered cables laid in conduits within the concrete and cement floor.

TRANSFORMER HOUSE.

The transformer house is thirteen feet by fifty-one feet six inches, and also built of concrete. It is fifty feet distant from the power-house. It contains seven step-up transformers, viz.: two banks of three each and one in reserve. They are of Bullock make, 300-kilovolt-ampere, water-cooled, oil-insulated, 2,200/19,050 volts, twenty-five cycles. Each bank is located in a separate room, and the seventh or spare transformer is in a third room. They stand upon rollers, which in turn rest upon T-rails set into concrete piers.

The spaces between the piers are filled with gravel and provided with subdrainage, so as to allow any oil to rapidly escape in case of leakage or accident. The water piping is connected up with unions and so arranged that every transformer is interchangeable with every other one, as far as water and electric connections are concerned.

A track runs the entire length of the building and at such an elevation that the floor of a car is at the same height as the rails which are imbedded in the concrete piers. Thus any transformer can be quickly rolled out upon the car, removed and another reconnected in its place in case of accident.

The penstocks are each tapped in the power-house, and after passing through shut-off and throttling valves under the control of the operator, water is delivered into a cylindrical steel tank, thirty-six inches diameter by twenty-four feet long. This storage tank is set upon a little knoll about twenty feet above the level of the transformers. From this tank the water circulates through the cooling coils of the transformers by gravity.

The transformers are connected in delta on the low-voltage side, and in Y on the high-voltage side, with ungrounded neutral.

THE HIGH-TENSION SWITCH-HOUSE.

The high-tension switch-house is sixteen feet by thirty-six feet; a frame structure covered with corrugated iron; twenty feet distant from the transformer house.

In it are two banks of "M-T" single-throw air-break switches, and General Electric alternating-current multiplex lightning arresters, connected up for the three-phase circuit.

POLE LINE.

The pole line extends almost due west from the plant to the substation in Eureka. The length is sixty-five miles. Of this, fifty-five miles are over a severely rugged mountainous country; the altitude of the plant is only 1,480 feet, and Eureka is at sea-level, but the line passes over several summits ranging from 4,500 to 5,500 feet in altitude. Fifty miles of its length lie in a heavily timbered country, requiring a tremendous amount of clearing, the trees ranging from two feet to four feet in diameter. It was necessary to construct a trail nearly the entire length of the line. The route deviates from a straight line only slightly and only where the topography made it unavoidable. It is a "thorough" transmission, so to speak, there being no taps on the line anywhere between the plant and the substation at Eureka. The line is a single circuit, three-phase, averaging thirty-five poles to the mile. The poles are redwood at the western end; in the inaccessible stretches the native red fir was the only wood available. The insulators are Locke two-piece single petticoat porcelain, eight and one-half inches in diameter. In the fog-belt a larger insulator of similar design is used. The pins are sun-dried eucalyptus, oiled, one and one-half inches diameter.

The spread of wires on the standard length spans is forty inches; the wire is No. 4 copper, except on some long spans where stranded cable is used.

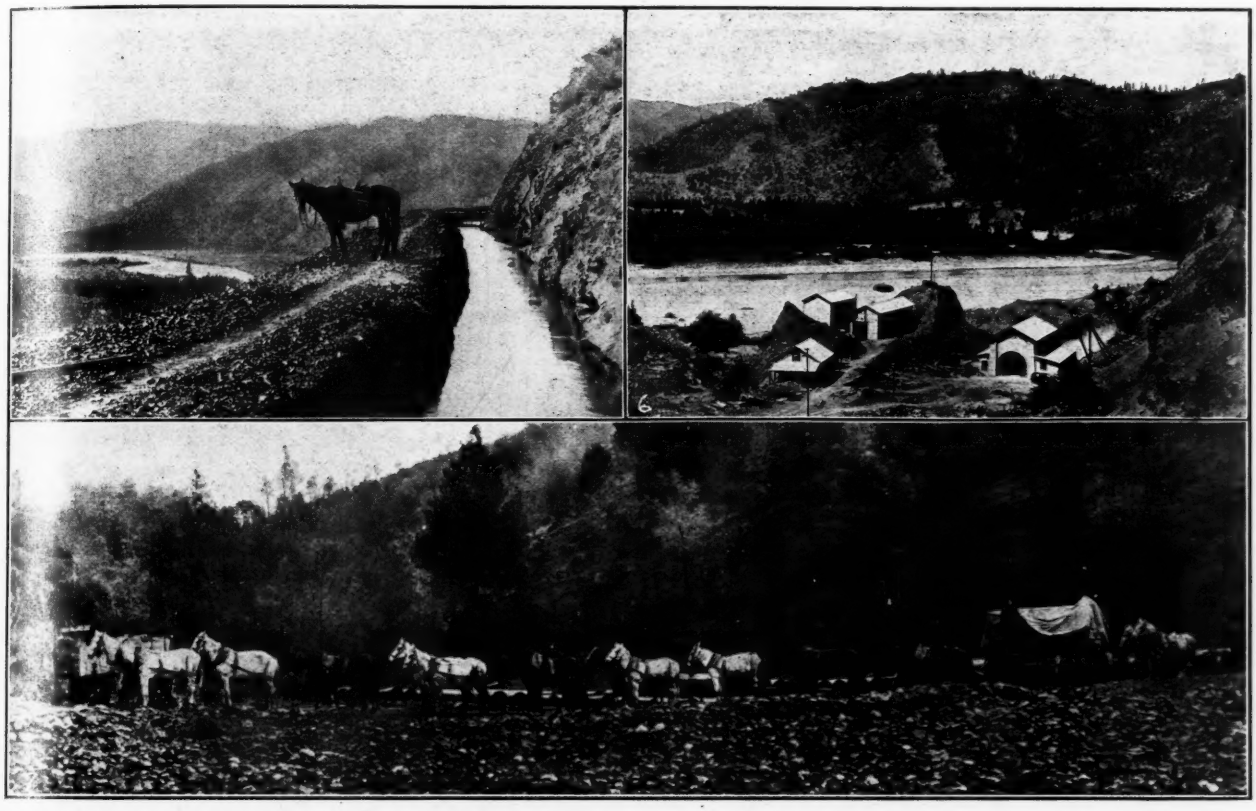
The length of spans varies from fifty to 1,400 feet, according to the conditions and topography of the country.

The telephone circuit is No. 10 B. B. galvanized wire, carried on glass insulators.

The potential at present used on the line is thirty kilovolts.

TELEPHONES.

Telephones made by the Stromberg-Carlson Telephone Manufacturing Com-



5—Section of Ditch through Which Water Is Diverted to the Plant of the North Mountain Power Company. 6—General View of the Trinity River Plant. 7—Eighteen-Horse Team Hauling Lower Half of a Stator of a 750-Kilowatt Bullock Alternator over Sixty Miles of Country Road from Nearest Railroad Station.

pany are connected to the line at several of the cabins which have been built for the accommodation of the patrolmen, and at frequent intervals are "pole-boxes," consisting of a magneto generator and batteries into which the patrolmen plug their pocket sets and thus have long-distance, loud-talking instruments.

SUBSTATION AT EUREKA.

The substation at Eureka includes an auxiliary steam plant as follows: two Babcock & Wilcox water-tube boilers fitted with Peabody patent oil-burning furnaces and a duplicate oil-pumping system; Goubert auxiliary feed-water heater; Wheeler "Admiralty" surface condenser, with self-contained, steam-driven air and circulating pumps, cooling water being taken from Humboldt bay, and a McIntosh & Seymour tandem-compound engine of nominal rating of 700 indicated horsepower. A jackshaft running at 500 revolutions per minute is connected to the engine by rope-drive. A Bullock rotary converter, 500-kilowatt, 500 revolutions per minute, six-pole, twenty-five-cycle, 550-volt, is arranged for direct-connection to this jackshaft by a jaw clutch, and so driven by the engine. This permits of carrying the load by steam when necessary to shut down the transmission line for repairs. The engine is fitted with a switchboard speed-control device. The clutch has a synchronism indicator in the nature of a lamp, so that the engine may be connected to the rotary while it is running at full speed on the power transmitted from the Trinity river plant.

For the rotary converter there are three Bullock transformers, 190-kilowatt, water-cooled, twenty-five-cycle, 30,000/352 volts. For stepping down for the local distributing system are three General Electric transformers, 400 kilowatts water-cooled.

For furnishing power to the sixty-cycle incandescent and arc-lighting circuits of the city of Eureka, a three-phase, sixty-cycle generator is driven by the rotary acting as a synchronous motor.

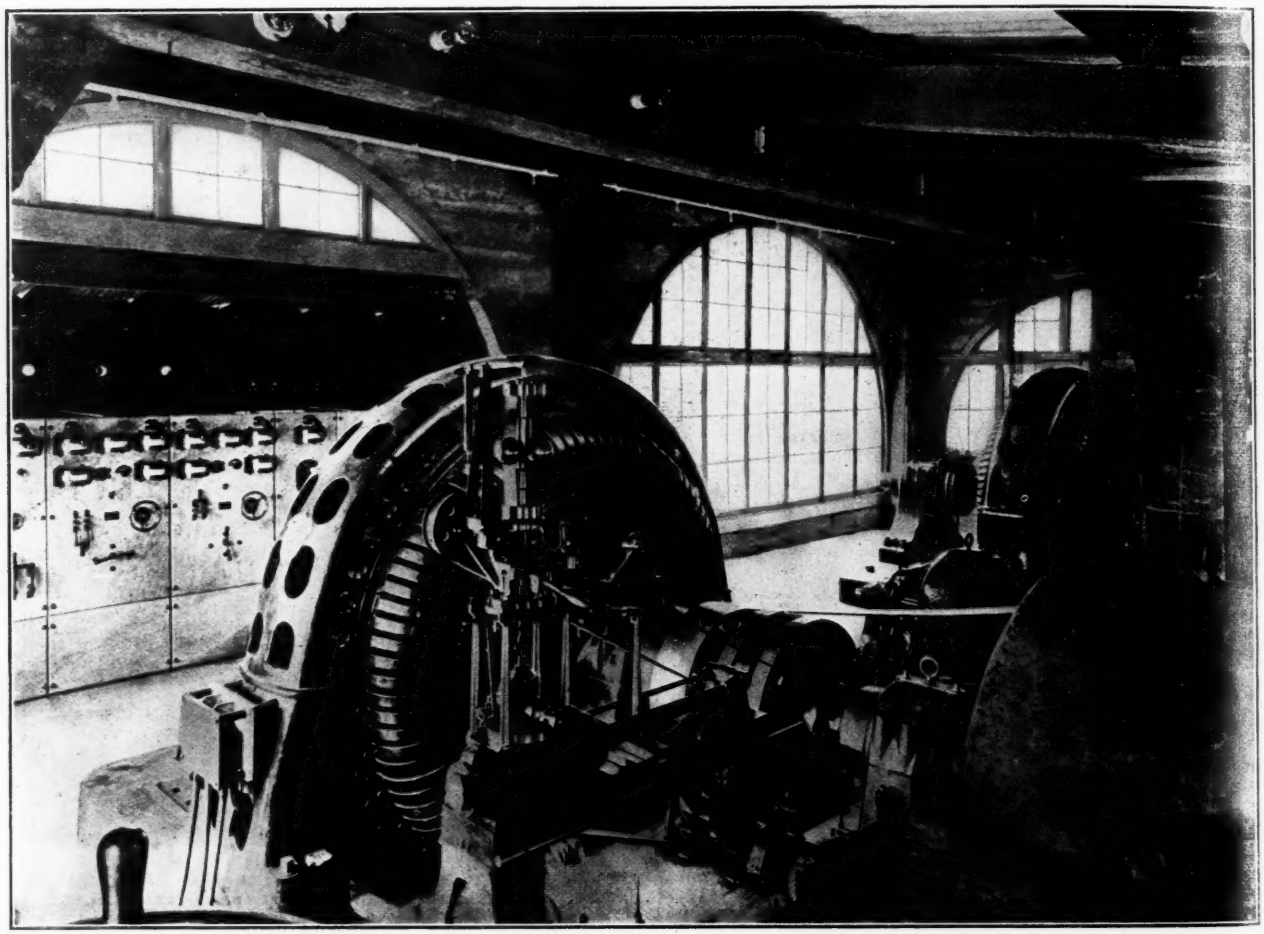
The substation is fitted with switchboards and high-tension switches suitable for handling this equipment.

A fuel oil-tank fifty-four feet in diameter by twenty-five feet deep, holding 10,000 barrels, has been built near the substation, and is connected to a dock on Humboldt bay by a pipe line.

The substation is thirty-one feet by 128 feet, built in the marsh on the water-front of Eureka. Heavy concrete foundations rest on redwood piles, cut off below low-tide level.

LOAD.

The load at present consists chiefly of lights in the city of Eureka. Some motors are already connected to the circuits, and the motor load is being rapidly developed. Local transmission lines are being constructed about the shores of Humboldt bay, and in a very short time the company will be supplying power to the local companies in Eureka's suburbs, not only for light, but for motors in the various industries of that rapidly developing region.



NEAR VIEW OF 750-KILOWATT BULLOCK ALTERNATOR, LOMBARD WATER-WHEEL GOVERNOR AND SWITCHBOARD, NORTH MOUNTAIN POWER COMPANY, TRINITY RIVER, CAL.

The market for copper is exceedingly strong, and for some time past has been growing stronger daily. Between November 25 and December 15 electrolytic wire bars advanced from seventeen and one-half cents to nineteen cents. Intrinsic conditions warrant the expectation of market strength for months to come.—*Copper Gossip.*

EFFICIENCIES.[1]

BY JAMES SWINBURNE.

The title of this address is put in the plural to prevent any misunderstanding as to its nature. Efficiency is, I believe, a catchword in party politics, and is therefore largely employed in connection with people who have no real output at all. This address, on the contrary, is concerned with real questions. The term "efficiency" is used by serious people to denote the rate of the useful part of the energy or power obtained, to the energy or power put in. There is another aspect of the question, and the term "efficiency" may be stretched to cover questions of money. For instance, if in a bargain you get fifteen shillings worth of goods for £1 the purchase may be said to have an efficiency of seventy-five per cent. But in cases of this sort it is not quite usual for a bargain to have an efficiency of more than 100 per cent from each point of view. This is because, in the case of a well conducted bargain, each of the parties, to use a legal word, gives what he prefers to part with for what he wants more; so that both are satisfied. But the seller may take another view; he may have bought an article for fifteen shillings and sold it for £1. In that case he apparently makes five shillings, and it might be called thirty-three per cent of the cost price or twenty-five per cent on the selling price. The term "efficiency" is not applied to such cases because "efficiency" is employed in cases where there is a partial loss, to show how much has not been lost. Cases of profit would be cases of efficiencies of over 100 per cent. A trader who looked upon buying at fifteen shillings and selling at £1 as making a profit of thirty-three per cent would really be deceiving himself, because in such cases it is not really a question of how much is made over and above the apparent purchase price, but of what profit is made per annum on his trade capital. Into this question all sorts of considerations enter that do not appear in the statement of simply buying and selling. If he is merely a trader who buys and sells he has to pay rent, incurs bad debts, loses stock through depreciation and other causes, and has to give his time to the work. He also may have to spend a good deal on advertising.

Another simple case is that of manufacturing. If an engine builder, for example, spends £1,000 on wages paid to men who have made an engine, and £1,000 for material, and sells an engine for £3,000, it is commonly said that he has no business with the odd £1,000; either he is said to have overcharged his customer £1,000, or he has robbed the workmen of £1,000, as it was their work that made the engine. Both these notions arise from ignorance; and this ignorance, like all other kinds of ignorance, does a great deal of harm. The argument that all the money paid to manufacturers should go to workmen who actually make the goods is always employed by the agitators who live by stirring up the passions, and flattering the weakness of their victims. It may seem strange to bring forward such questions in an address to electrical engineers; but I want to urge the importance of looking at things from a money point of view, because all engineering is a question of money; and I want to bring some money questions as well as energy and power questions before you to-night.

In making any bargains with Nature, we always lose in a sense; and we are so accustomed to it that we take it quite contentedly, and merely try to lose as little as possible in the transaction. As I said before, the relation of what we do not lose to the whole is termed the "efficiency." In dealing with our fellow men we always hope to make a profit, and we sometimes do. In such a case it might be correct to talk of an efficiency of over 100 per cent, but it would be unusual. It might be still more unusual to say a bankruptcy which resulted in a payment of six shillings eightpence on the £ was a transaction with an efficiency of thirty-three and one-third per cent. But there would be enough justification for such a proceeding to enable me to discuss some aspects, even of electrical commerce, under the head of "efficiency."

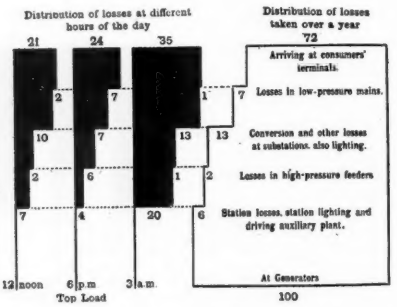
Heat includes what is called sensible heat, or heat that makes things hot; latent heat, such as the heat that disappears when ice is melted or water vaporized at constant temperature, and chemical energy. I must tell you that it is not orthodox to call chemical energy heat; and you will not find any such treatment of the subject in books on thermodynamics. At present I believe I am alone in classing chemical energy or defining heat so as to include chemical energy; but the treatment of chemical energy in chemical thermodynamics is quite consistent with my definition, so I may use it provided I give you due warning of any heterodoxy. I think that it is not realized that chemical energy is necessarily low-grade energy, only partially convertible into work. This involves the idea of chemical temperature which may be important in chemistry in discussing the way any given possible reaction will go; but we are not concerned with that here. It will be said that the coal is cold when it is put into the furnace, as cold as the air in fact; so that if this idea is right none of the chemical energy is available. But I must give some idea of what I mean by chemical temperature. If carbon and oxygen are heated to a high enough temperature you get a state in which, on the least fall of temperature, the carbon and oxygen combine and give out sensible heat at that temperature, under the other circumstances that obtain. The least increase of temperature, however, causes the carbon and oxygen to separate again, absorbing sensible heat. At this temperature, therefore, under the pressure and quantitative relations of the carbon, oxygen and carbon monoxide, sensible heat and chemical energy are interchangeable. This temperature may be called the chemical temperature of the energy of carbon and oxygen. I need not trouble you with discussions as to whether the energy is really in the carbon or the oxygen or the ether, or as to the effect of pressure and proportions of carbon, oxygen and monoxide on the reaction. I merely want to give you a broad idea of carbon as having or controlling chemical energy, or heat with a corresponding "chemical temperature" of the order of 3,000 degrees centigrade or more. If the burning coal, containing, of course, other constituents, such as hydrocarbons with other chemical temperatures, could hand over their heat at 3,000 degrees centigrade, nearly all of it would be available. As the heat is finally rejected at condenser temperature of 100 degrees or so, 3,000—100/3,000, or about ninety-seven per cent of it would be available. But the boiler takes it up at under 500 degrees centigrade absolute, so that five-sixths is degraded or rendered unavailable right off.

It might be supposed that there is enormous room for improvement in the steam engine. An efficiency diagram looks as if all the loss is due to the engine which gets sixty-eight per cent and only gives out seven per cent, but we must not be hard upon the engine. It is turning out work, or high-grade energy, and it is receiving heat, or low-grade energy. This engine is probably taking in steam at about 450 degrees centigrade absolute, and rejecting it at about 375 degrees centigrade absolute, so as it could, if perfect, only turn out $68 \times 75 \div 450 = 11.3$; so it is not really doing so badly. The

[1] Abstract of an address delivered November 24 to the students of the Manchester local section of the Institution of Electrical Engineers.

real loss is between the fuel and the boiler, and it is not loss of energy, but loss of availability. Though the chemical is low-grade energy, it has such a high chemical temperature that ninety-seven per cent is theoretically available; but we can not run a boiler and engine between 3,000 degrees centigrade and 4,000 degrees centigrade. Engineers are always trying to improve the results by using higher and higher temperatures; but as you can not use the pressures that would then correspond with saturated steam you can only superheat. This does not mean that most of the heat is taken in at the high temperature, and the resulting gain is chiefly due to such things as reduction of cylinder condensation. There are great practical difficulties in reducing the lower temperature. The condenser reduces it to about 100 degrees centigrade or 373 degrees centigrade absolute; but even then the steam is not completely expanded, and blows into the condenser under pressure. The efficiency has been raised more recently by reducing the lower temperature limit by means of sulphur dioxide. I do not know who was first to propose this. Rayleigh suggested it as early as 1876. It is being put in practice now in Germany.

At this stage I would like to say that this is given as an address in my own name, because I was asked to give an address. If it had been a paper, Mr. Walter Claypoole, lecturer on electric lighting and power distribution at Croydon Central Polytechnic, would have been joint author



LOSSES ON METROPOLITAN ELECTRIC SUPPLY COMPANIES SYSTEM.

nominally, as well as in reality. I am indebted to him for all the hard work.

The right-hand part of the accompanying diagram illustrates the yearly losses in the Metropolitan system, supplying several London areas from Willesden. I am indebted to Mr. Highfield for the figures. It will be seen that the transformers are very efficient, and when they can be cut out at light load so that the transformers in use are always well loaded, the efficiency can be made very high. The diagram is also a little deceptive, because it takes no notice of the time at which the energy is wasted. Energy wasted at the time of station full load is serious, because if it were not wasted it might be sold, or else the station might be a little smaller in proportion. But most of the waste in transformers is at light loads, and it costs very little extra to generate extra power at times of light load, for it costs nothing extra in capital, superintendence or labor, and it does not cost much in coal, for the boilers have to be kept hot, and some engines have to be kept running in any case. These points have to be borne in mind in considering the meaning of such diagrams. It will be seen that there is a loss of six per cent in "station losses," only two per cent feeder losses to substations and thirteen per cent conversion losses and lighting of the substations.

These are for the year. They alter from time to time, so the wastes are shown black to the left for three representative times. Thus the station losses are seven per cent at noon, four per cent at top load and twenty per cent at three in the morning, and so on. This is because the losses do not vary in proportion to the loads. Through the various sources of waste energy the final result is that there is twenty-one per cent loss at noon, or seventy-nine per cent efficiency, and seventy-four per cent efficiency at 6 P. M., and up to sixty-five per cent at 3 A. M., which is astonishingly good when the system is considered.

If a station is run by a town the accounts must be kept by an absurd system. Towns are generally concerned with such things as sewage systems, in which there is no profit and loss account. The town may not treat its sewage system as a permanent asset at all. It has to borrow money to put down its sewage system, say £100,000 at three per cent. Then it has to pay £3,000 a year interest. But that is not all—it has to pay back the whole of the £100,000 in a certain number of years. To do this it has to provide out of the rates a sinking fund, such that in the prescribed term of years the whole of the debt is paid off. The town then has a sewage system to the good, which has been paid for over many years out of the rates. The town, therefore, does not save money like the private individual and then buy what it can afford. I do not think it would be allowed to do such a rational thing; it has to borrow money for everything and pay it back over a term of years. The length of the term has no reference whatever to the nature of the work done, as the work is not in any way security for the loan; the local rates are the security. There is an epidemic of outcry just now about municipal indebtedness, but it is apt to give a totally wrong impression to the average reader, as he does not realize that municipalities must be in debt, owing to the way these things are arranged. For a private individual always to be in debt would be bad; for a town it is another matter; the only question is how much the town ought to be in debt. The nation itself does business in the same sort of way; it has no ready money, and when anything has to be done it borrows. But local authorities are now taking up such businesses as electric supply and tramways, which have profit and loss sides; but they are obliged to work the businesses on the same lines as town improvements, which is absurd. A municipal electric light scheme is thus worked under absurd difficulties. It is like a public company that has a negative capital—that is to say, all its money is borrowed. The shareholders are the ratepayers. They hold shares depending on the rate assessments. The dividends are generally negative. All the shareholders are so by compulsion if they live in the place. The only thing they can do if they do not want to be shareholders in such undertakings is to move off to another town; but then they become shareholders in another set of ventures. I believe the only way to avoid being shareholders in these compulsory undertakings is to live in a barge on a canal. Be this as it may, the undertaking, though a profit and loss concern, must keep its accounts on the same principle as if it were a sewage system. To begin with, the town may only borrow enough money to put down the plant. This has to be paid off, as already explained, by the sinking fund, which returns all the borrowed money, in say twenty years. The plant may last ten years, or it may last fifty years; that has nothing to do with the case. If the plant lasted twenty years and then went into powder, like Holmes's "one-hoss shay," the sinking fund would correspond with correct depreciation. If it lasts less, something more should be allowed, and less should be written off for the parts that will last longer. This right depreciation to be allowed in municipal works is a burning question between the advocates of municipal trading and its opponents. Again, a private concern would start business with enough capital to put down the station, and to run it at a loss for a year or two until it turned the corner. The municipality may not

do anything as sensible as that; it may only borrow money enough to put down the station, and the first few years' losses must be paid for out of the rates for these years. This sometimes excites the ratepayers. Almost any business has to be run at a loss at first, and enough capital is provided to meet the deficit, and when the business pays it ought to pay on the whole capital. No one would think of starting, say a works, with no working capital at all, and distributing a negative dividend during the next few years to pay the losses. This is one of the many absurd conditions under which municipal work has to suffer. In one case a lovingly solicitous gas company felt that it was hard that a municipality should lose during the first years, so it got a clause inserted to the effect that if there were a loss the price should be raised and raised until there was either no loss or no customers; it did not matter which, though in its heart of hearts the gas company preferred the latter. This clause was solemnly inserted in one or two acts by the collective wisdom of the country. It may interest you to realize that the large commercial interests of this country are controlled by a set of people who think that if a manufacture does not pay, the simple expedient of raising the price will put things right.

Referring to the comparative cost of different artificial illuminants, if electrical energy costs fourpence a Board of Trade unit, an ordinary glow lamp will give nearly 800 candle-hours for one shilling. A flame arc with energy at threepence gives you 14,000 candle-hours. It must be remembered that the one shilling is all spent on energy, nothing is allowed for renewal of lamps, interest on fittings, meter rents, interest on arc lamp, cost of carbons or labor. For one shilling, with energy at fivepence, you get about the same light as with a flat-flame gas burner and gas at four shillings. The ordinary oil lamp, with paraffin at eightpence a gallon, beats them both hollow, and it is out of the running with acetylene. The great fight between electricity and gas has been fought with flat-flame burners and carbon lamps, and there has been much discussion. I have been accused of a strong partiality for electric light; but I feel impartial; I really do not know which is the worst. The gas mantle makes an enormous difference, and brings gas, say, at three shillings, ahead of everything, but the mercury and flame arcs, at say, fourpence halfpenny a unit. The flame arc is essentially for large lights, while the mantle lights can be made quite small. The comparison is, I repeat, only for the same money paid for gas or energy. To make a real comparison many other factors are to be taken into account. There is the interest on the mercury lamp for one thing; then its color is not good; and if you had carbon lamps the efficiency goes down. On the other side, however, you have to estimate the cost of mantles, the trouble and worry of breakages, and of the jets getting stopped up, and so on. Even then it must be clear that the mantle has a large margin of economy for the house lamps, such as the Nernst, the metal and the carbon incandescents. For outdoor use, and for large buildings, the flame arc seems to have plenty of margin over the mantle, though large mantle lamps are even better than some of the smaller ones.

In addition to the cost of lamps, mantles, etc., we must remember that if an illuminant spoils the decorations the extra cost of redecorating should be charged against it. Gas blackens the ceilings and destroys paint, and so on; and the extra cost of decoration may be as heavy as the whole cost of electric light, in which case it does not pay to employ gas at any price. The argument annoys the gas industry, so it is sound and good.

New York Electrical Trades Society.

The New York Electrical Trades Society held its annual meeting and dinner on the evening of Tuesday, December 12. About fifty members were present, and a very happy evening was spent in the discussion of the business affairs of the organization and in listening to the toasts at the banquet. The officers' reports showed a flourishing condition of affairs, and emphasized the importance of the organization to the members, through the facilities which are secured in the collection of accounts. The society undertakes the collection of many accounts, and through its methods makes an annual saving of a considerable amount to each member of the society.

The election of officers resulted as follows:

President, John H. Dale, the Dale Company, New York city.

Vice-president, R. B. Corey, American Circular Loom Company, New York city.

Treasurer, B. H. Ellis, Manhattan Electrical Supply Company, New York city.

Secretary and counsel, Franz Neilson, New York city.

The other members of the executive committee elected are as follows: P. M. Haight, Sprague Electric Company, New York city; G. E. Pingree, Western Electric Company, Chicago, Ill.; A. S. DeVeau, DeVeau Telephone Manufacturing Company, New York city; W. E. Carmichael, Diehl Manufacturing Company, Elizabethport, N. J.

TECHNICAL EDUCATION OF THE TWENTIETH CENTURY.[1]

BY JOHN CASSAN WAIT.

The foundation of a technical training consists of nature's laws and phenomena, and as nature's laws are fixed and inexorable, a student possessed of a knowledge of what has been, knows what will be, and it is this that forms the groundwork of the twentieth century system of education. But this is not all; it should go further; it should elevate the new generation to a higher plane than mere investigation; it should cultivate powers, a higher ideal and a struggle for genius, the divine, the creative.

An education implies first, a student or scholar to be educated, second, a process or method by which the education is to be acquired, and third, an ulterior purpose or ultimate utilization of the education to some good aim and end.

When the high school or seminary training is finished, several questions present themselves to a young person, among which are three, *viz.:* (1) What shall I do or become? (2) Shall I attend school or become an apprentice? (3) Shall I enter the general or technical courses of instruction? The first question must be answered by the tastes, qualifications and opportunities possessed by the person. The second question is usually determined by the pecuniary limitation of the person. The third question depends upon the advantages to be secured or benefits to be derived, and is a subject for duscussion under our topic.

It is not a new subject, but there may be some new things in it, in the light of another's experience. I am not an advocate of an extended general course in college as a condition precedent to technical training.

I am no advocate of sixteen years of education before a man or woman becomes self-supporting. He or she is depending too long upon charity or is assuming a debt which he may never repay. It dwarfs the spirit of independence and self-reliance which the twentieth century needs so much. A young man who accepts his parents' or relatives' support to the age of twenty-four or twenty-six years has forfeited one of the heavenly attributes of human character, that of manly self-reliance. I would not expect great things of such a young man. If not blessed with influential relatives or friends he must gain his experience and acquire

[1] Abstract of Founder's Day Address, November 30, 1905, at the Thomas S. Clarkson School of Technology, Potsdam, N. Y.

a clientele. His married life is postponed and his ideal life shortened by a decade.

In the earlier days of education, theories and laws were assumed by one school, and controverted by others. Fortunately, all this has been changed and modern methods of education are those where observation is cultivated and the reasoning faculties directed to explain the phenomena observed. This is the process of imparting information by directing the student in paths richly bordered with the fruits of wisdom.

The difficulties are removed. The student, though in quest of exercise, has had everything done to lessen the labor. Those obstacles that give to the forest trail its glories, or to the mountain stream its power, have been removed and the Venetian canal has been substituted.

What is the result? It is that all students have been to Venice; all have observed and been taught the same things. The original trend or natural taste of the child or youth has been limited to the banks of your canal. Your graduates are all alike. Genius has been dwarfed and freedom enslaved.

We need to cultivate heroes whose spirits no conventionalities could restrain and who overcame and turned the tide of the world's ignorance, prejudice and jealousies to the light and the truth. They are originators. They have visions unlike the average man.

These limitations in education do not differ solely with the period, but they are greatly affected by the conditions and localities. They are less marked in the smaller and outlying schools than those in our great communities.

In cities and the great universities located therein, the people forget that the sky overhead is not adamant or lignum. Their chief sources of knowledge are books. Much profitable learning comes from primitive life and from the discomforts of human existence. A millennium of human comfort and convenience is not healthful to intellectual progress nor to physical development.

It is notorious that the strong men and women, those who possess mental and physical superiority, in our schools, in business and in our industrial and professional occupations, are largely from the country.

In the general courses the studies that you pursue are determined, in the larger universities, by the students' own election. The tendency is toward this plan. By it the student may take his collegiate course and at the same time pursue courses required in the professional classes. This will lead to the three years' collegiate course and is a step in the right direction, if the work of the student be directed or supervised. If he be required to elect his profession or business, and to take subjects prescribed or acknowledged to be advantageous in the vocation adopted, then it is, to my mind, most desirable. If the student be permitted to follow his own inclinations, which in four cases out of five will be those avenues of least effort, then the system is detrimental. The student may know less at graduation than at entrance. If he elect the elementary subjects in the various departments, acquire what is popularly known as general culture, and secure the requisite number of points or half courses, he can graduate with a degree, though that may mean positively nothing as an indication of what the student knows.

There is the choice of schools to consider, the large and the small, those in cities and those in country, the general and the technical. But outside of these there are also for consideration the systems that prevail. Some of the schools believe in pursuing several subjects at once, while others pursue one or two subjects only at a time. The various systems have many advocates. Each maintains that its system is the system. There is the choice between the elective and the prescribed courses of study, the experimental and the theoretical systems of teaching sciences.

In my opinion, it is those institutions which combine the theoretical and the practical, which limit to a moderate degree the number of courses, which prescribe courses for lower classmen and leave the election to upper classmen, that truly derive the benefits of both systems.

Cultivate exquisite care and practise heroic effort. As our country grows older and competition becomes greater, the requirements of an education increase. Students who expect and hope to excel in the competition that prevails in our great cities must have something better or something different from that possessed by others.

Refinement should be applied to all that you do and undertake. Your mental training should be refined on the same plan. Put an exquisite finish upon your work. That is what makes the artist; it is what distinguishes the actor and soldier from the business man or laborer, and it is what makes the successful technician or engineer in the present day.

Technical training, as offered by our industrial schools, tends to develop abnormally particular lines of the intellect and greatly enlarges the scope of one's observations and power in certain directions. Such a development has been compared to the abnormal development of the five senses. Yet the world has need of such men. He may not be wanted frequently, but occasionally his services are required when they command great prices.

The prevailing idea is that a complete education should be acquired at school. The average graduate from college or technical school hails his degree at the final goal of his educational ambitions. Few study or expect to study after graduation, except, perhaps, in short crams for a civil service or professional examination.

Such is not the object. The school's aim is to qualify you to study. If you do not continue with your studies you are soon going backward, and at a rate that will appal you when you come into competition with some recent graduate fresh from his studies.

A far-seeing man will, before spending very much time or money for a thing, enquire what specific uses he will make of it, and he will select the object of his purchase with a view to its qualities and its adaptations. A young man who enters college or a technical school should have some idea of what his tastes and capacities are and should be directed in the lines where his abilities would be best applied and cultivated. I am not one to advise that every man should be a perfect man; neither do I advocate that a whimsical and indolent youth should be permitted to escape essential training in mathematics and sciences by his declaration that he does not like them and he does like music, art and other subjects which gain flattery and applause. Yet for one's life work, it is a grave misfortune for one to school himself or herself in a business in which they have not a real liking and to which they can not bring enthusiasm. Elect something to your liking and something in which there are opportunities and for which there is a demand.

The utilization of technical training in the industrial pursuits and development is everywhere apparent in this country. To no other one element are the country and the people more indebted for their wealth and prosperity. The physical comforts at home, of business and of travel are due to the marvelous provision of the technician.

The economic value of this training is illustrated by the trade, domestic as well as foreign. No country can have claims to world power until it develops the industrial talents of its people and the natural resources of the land. The balance of

power remains where the scientific, industrial and mechanical arts are best treated.

Education of this century should not be confined to book learning nor to the study of mathematical and physical laws. Some time should be given to economics and sociology. Methods and means of conserving and protecting what is required are quite as important as are the ways, methods and means of acquiring. Close upon the footsteps of progress in its march is trade, with its competition and its protector, economy. The wasteful methods of the pioneer can not survive the rivalry of commerce. Economy in the production and utilization of materials or power is what effects great savings, and it is the man who can effect great savings who can command a salary commensurate with his savings.

But the twentieth century education should not only cultivate the courage and capacity of a man or woman to cope with nature but should also give some insight into the laws, institutions and systems of society. It frequently takes some people the best years of their life to become acquainted with themselves and to discover what they really are to the world. Some men take years to overcome the natural diffidence and timidity that possess them which might be corrected in youth by prosper surroundings and by a kindly interest of their teachers.

A discussion of technical education in this century should not omit some reflection upon the social inequalities that are certain to exist. We may look back upon a century mighty in its achievements, gigantic in its forward stride, matchless in its intellectual expansion, industry and invention, in its manifoldness and the vastness of its enterprises, the grandest of all the centuries in history. The heavy burden of labor has been taken from the shoulders of men, and the workman has been made the equal of his neighbor. He has better food, raiment and shelter and better remuneration for his time.

The technical schools should aim to turn out men who can undertake the instruction and improvement of this class of people. Trade schools should be erected and instruction offered in the useful arts. They control the great avenues of commerce, the necessities of life—food, fuel and raiment. Never was there the necessity for the unity of men and the realization of the dependence of the polite upon the industrial.

The education of the twentieth century will, I predict, enlighten every continent on the globe. What has been begun in the past century will lead to greater and more lasting results in this century. The twentieth century should lead the human race to heights which shall strengthen the faltering steps of art, philosophy and religion.

What the twentieth century demands is the cultivation of originality and the development of the creative genius of students. Creation should be the highest aim of every student. A small thing created may be truly greater than a large thing borrowed, and the original thought or design of vastly greater import than any imitation. The present century requires the development of geniuses and especially in the technical fields. Old and trodden fields must be departed from and new, though rough, trails taken. New practices and methods must be devised, and these are more likely to be discovered by departure from, than by following in the channels hewn by our predecessors.

The twentieth century education should embody artistic treatment in structural work and in mechanical contrivance—a relaxation from the intensely practical and economical to a study of what is pleasing and what is beautiful. Some have an idea that there is not much that is beautiful in the mechanical and industrial. Nothing is further from the truth.

It is for the twentieth century education to impart the beautiful and artistic to the useful, to lend inspiration and give expression to the deeper feelings of industrial life, its burdens, its struggles, its rewards and its glorious victories. The twentieth century should make its technically educated men something more than mechanicians, something more than the mere directors of processes. Men and women should be taught to vary their employment and to seek recreation in the profitable exercise of their intellectual faculties. The spirit of man needs more than gain, more than crowning success of its efforts, more than the applause of fellow men; it needs the hope and cheer of the life everlasting.

The Electric Power Plant of the Lakefield (Ontario) Portland Cement Company.

The Lakefield Portland Cement Company, of Lakefield, Peterborough county, Ontario, is the first company in Canada to use electric power in its cement works. The company has now two power plants in operation. The first is located at Young's Point, at the foot of Clear lake and Stony lake. The fall from Clear lake to the Otonabee river gives a head of only seven feet, but, due to the large capacity of the lakes, this head is maintained. Work on this plant was started in 1899 and completed in November of the following year. The machinery consists of four sixty-eight-inch turbines, driving by means of gears, a 400-kilowatt, 550-volt, three-phase, sixty-cycle generator. The output of the generator is stepped up to 11,600 volts by means of three single-phase, air-cooled transformers, each rated at 135 kilowatts. The length of the transmission line is five and one-half miles. The line consists of three No. 6 copper wires, carried on one four-pin cross-arm. Two wires on one side of the arm are placed thirteen inches apart, and the other eighteen inches from the centre conductor. A barbed wire is fastened on top of the poles and grounded at every fifth pole. There are two transpositions on this line, dividing it into three equal sections. During the summer of 1902 the output of the cement works had so increased that an addition to the power plant became necessary. A site was secured at locks No. 3 of the Lakefield division of the Trent Valley canal, two and one-half miles southeast of Lakefield. The hydraulic works were built of reenforced cement. The power-house was built of limestone. The plant contains four sixty-eight-inch vertical turbines, working under a twelve-foot head, and driving, through gearing, a 1,000-kilowatt, 11,500-volt, sixty-cycle, three-phase, revolving-field alternator. The transmission line consists of three No. 2 B. & S. copper wires carried as before on one cross-arm. The two on one side are eleven inches apart; the third, on the other side of the pole, sixteen inches from the centre wire. This pole line carries also the telephone circuit, which is transposed every second pole. The telephone line is placed seven feet below the transmission line. At the cement works there is a substation adjoining the motor room. Here the pressure is lowered from 11,000 volts to 575 volts by means of six air-cooled, single-phase transformers, each rated at 135 kilowatts. There are also two fifteen-kilowatt, oil-cooled transformers, lowering the secondary current from 575 volts to 230 and 115 volts for a three-wire system of incandescent and enclosed arc lighting. In the motor room there is a 600-horse-power, 11,000-volt, three-phase, sixty-cycle synchronous motor, direct-connected to a line of shafting, from which are driven seven grinding mills. This motor is started by a fifty-horse-power induction motor, to which it is geared. Scattered throughout the works for driving the machinery are four 100-horse-power motors, five of fifty horse-power, one of fifteen horse-power and two of ten horse-power. These are all of the induction type. The daily output of the large works is 1,500 barrels.—*Canadian Electrical News (Toronto), December.*

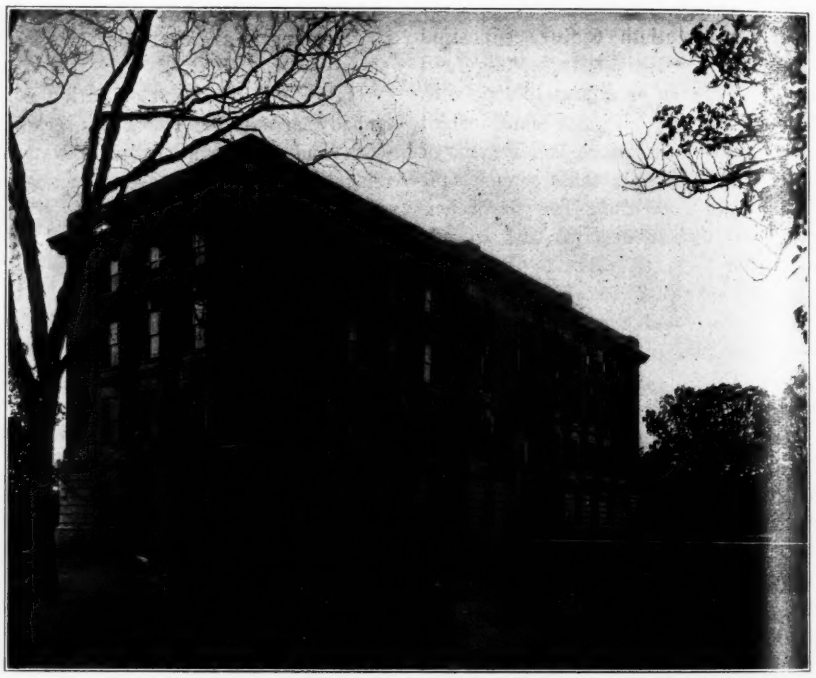
The Buildings of the National Bureau of Standards.[1]

IMMEDIATELY after the passage of the act establishing the Bureau of Standards, March 3, 1901, the planning of the laboratories was begun, as well as the selection of the scientific staff, and the development of some of the more important methods of testing. The first and one of the most important problems which presented itself was the selection of a site. The site secured is about 7.5 acres in extent and is situated in the northwest section of the District of Columbia, about 2.5 miles from the White House on Connecticut avenue extended. The location has proved by experience to be a most excellent one, and while it is sufficiently large for immediate purposes, steps have been taken toward securing sufficient adjacent property to protect the bureau from mechanical and electrical disturbances that may arise with the future development of the city.

It was decided to erect two buildings, one of which should contain the mechanical plant, instrument shop, and other work requiring heavy apparatus; the other, a physical laboratory, situated at some distance from the first, and as far as possible free from machinery or mechanical disturbances. The amount appropriated for the buildings, exclusive of the equipment, $325,000, would not permit of ornamental or expensive construction; nevertheless, it was sufficient to erect two strong, substantial, fireproof buildings, of dark-red brick, trimmed with buff Bedford limestone, and of a style well suited for laboratories. A third building, to accommodate machinery for the liquefaction of gases, is nearly completed; it is practically an extension of the mechanical laboratory to the west.

It is purposed to erect a similar but larger building at the east of the mechanical laboratory for the testing of engineering instruments, the strength and other properties of materials. At the east and west ends of the physical laboratory it is purposed to erect in the future two buildings, each about the size of the present physical laboratory, one to be devoted to electrical work, the other as a chemical and metallurgical laboratory. The entire group of buildings will be connected by tunnels through which heat, power, light and other facilities will be distributed from the mechanical laboratory. In designing the buildings and their equipment special attention has been paid to the production and distribution of general laboratory facilities, the details of which will be described later. The work of many physical laboratories is seriously handicapped by the lack of these facilities, such as a sufficient range of temperature, pressure and electrical current. Often the provision of some special facility necessitates a greater expenditure of labor and time than the solution of the problem in hand. The testing work of the bureau also requires a complete variety and range of these facilities.

One of the first principles laid down in the general specifications of the laboratory was that it should be possible to install at any time pipes or wires leading from the mechanical plant to the various laboratory rooms, or from one room to another. This principle has been rigorously carried out and will be adhered to in all future buildings. Another feature incorporated, as far as possible, is that all laboratory rooms shall be general in character, that is to say, all are provided with the same facilities, temperature regulation and conveniences, varying only in the special equipment installed, so that any room in the physical laboratory would serve almost equally well for investigations or testing in optics, electricity, heat or for precision measurements of length, mass and capacity. The space beneath the first floor of the physical laboratory is unexcavated, thus obviating all fixed piers of masonry, but which may be installed when and where necessary or removed in case they are not needed. The heavy wall brackets are attached to the wall in such a manner that they may also be removed in case the wall space is required for other purposes. The physical building has now been occupied for about a year and has been found to be exceedingly well adapted to the purpose for which it was designed.



PHYSICAL BUILDING, FROM THE NORTHEAST—NATIONAL BUREAU OF STANDARDS.

THE MECHANICAL EQUIPMENT.

The mechanical building contains the mechanical and electrical plant, the instrument shop, about one-half of the electrical work, photometry and engineering testing. It stands on ground sloping toward the north so that the north part of the basement story is wholly above ground, but projects only a few feet above it on the south. The accompanying views of the building were taken before the grading of the grounds was completed. The building is 135 feet long east and west, forty-eight feet wide at the ends and fifty-eight feet wide in the centre. An extension of the basements wholly below the ground level on the south is twenty feet wide and projects twenty-five feet east and west beyond the main portion of the building, shown herewith.

[1] Taken from a paper presented by Dr. S. W. Stratton and Dr. E. B. Rosa, at the 201st meeting of the American Institute of Electrical Engineers, New York, November 24, 1905.

This increases the floor area of the basement by fifty per cent, affording ample accommodation for the mechanical and electrical plant on this floor.

The boiler room is forty-two feet square and nineteen feet high, the floor being five feet below the engine-room floor, and like the engine and dynamo room it is lined with white-enameled brick. Two water-tube boilers of 125 horse-power each have been installed, together with an economizer and forced draught. Space is reserved for additional boilers with a final capacity of 500 horse-power. The platform along the north side of the boiler room accommodates the filters, electric and steam high-pressure water-pumps, boiler-feed pumps, feed-water heater and other auxiliary machines. Under the platform are located the heater for the hot-water service, pressure tanks for the cold-water service, storage tank, etc.

The engine and dynamo room is eighty-seven feet long and has an average width of twenty-four feet. The larger of the two engines is a tandem compound of 150 horse-power, driving two direct-current 37.5-kilowatt generators, each giving 300 amperes at 120 volts, connected in a three-wire system. The smaller engine, shown at the right on page 1017, has a capacity of forty horse-power and, like the larger engine, drives two direct-current generators. Beyond the engines there are the following machines, some of which have been installed since the accompanying picture was taken.

1. A double motor-driven booster for charging storage cells, having a capacity on each side of 200 amperes at thirty volts, and which is also used alone to charge storage batteries of relatively low voltage and large current capacity.

2. A pair of two-phase alternators, surface wound, and giving an electromotive force of nearly sine wave form, direct-connected to a driving motor. One machine gives sixty cycles and the other 180; the two may be placed in series, and the wave form varied through wide limits by varying the relative amplitudes and phases of the two waves. By using them separately and varying the speed considerable ranges in frequencies may be obtained.

3. Another three-machine set contains two sixty-cycle, three-phase alternators, the relative phases of which may be varied by shifting the field of one of them. Thus, connecting one to the current coil and the other to the voltage coil of any instrument, any required power-factor may be obtained.

4. A second smaller set of a similar kind gives two sixty-cycle currents of adjustable phase relation. This is useful in calibrating phase indicators, as well as testing power-measuring instruments.

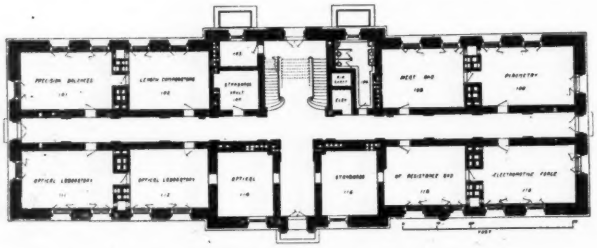
MECHANICAL BUILDING, FROM THE SOUTHWEST—NATIONAL BUREAU OF STANDARDS.

5. A three-phase 120-cycle alternator, driven by an inverted synchronous converter used as a motor, giving alternating current at sixty cycles.

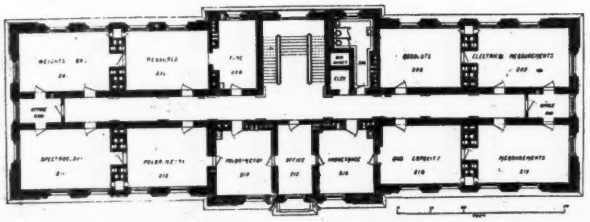
LOW TEMPERATURE LABORATORY, UNDER CONSTRUCTION—NATIONAL BUREAU OF STANDARDS.

6. A ten-machine set has been built and is soon to be installed. This set contains eight alternators and two driving motors, all direct-connected; but capable of being uncoupled in the middle and operated as two independent sets. One set has, besides the driving motor, three alternators of six, eighteen and thirty poles respectively, giving 60, 180 and 300 cycles, sine wave form, and capable of being joined in series, so varying the wave form. The second set has a driving motor and five alternators, giving 420, 540, 660, 788 and 900 cycles respectively. All the machines may be joined in series, as they have the same current capacity.

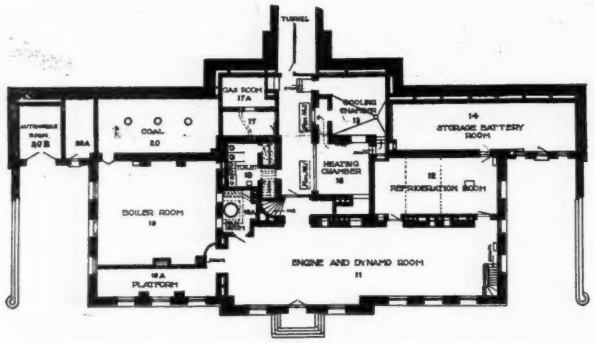
namely, twenty amperes. The voltages, however, decrease gradually from 250 for the largest to ten for the smallest. When joined in series all the odd harmonics to the fifteenth will be present in the electromotive force, or any may be quickly cut out. The wave form can be varied indefinitely by varying the number of harmonics employed and their relative intensities and phases. This machine will be very useful in testing and research, not only for varying wave form, but for obtaining a great variety of frequencies. The switchboard, which is now building, will be equipped with hot-wire instruments, arranged to show what components enter into the resultant electromotive force. The operating switches give quick



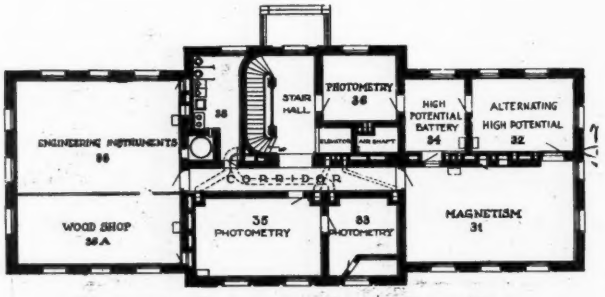
PHYSICAL LABORATORY—FIRST FLOOR PLAN.



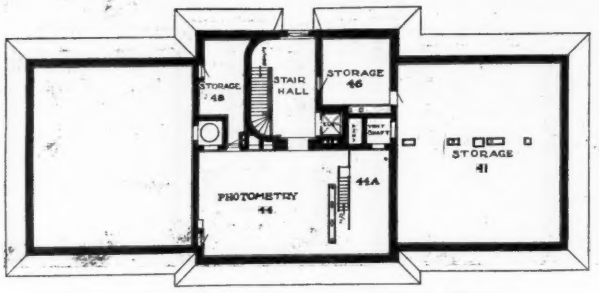
PHYSICAL LABORATORY—SECOND FLOOR PLAN.



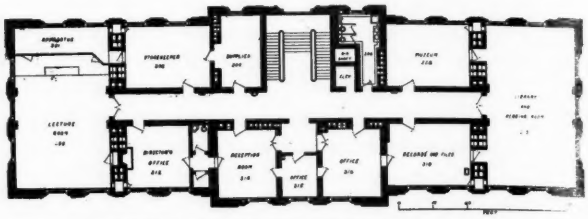
MECHANICAL LABORATORY—BASEMENT FLOOR PLAN.



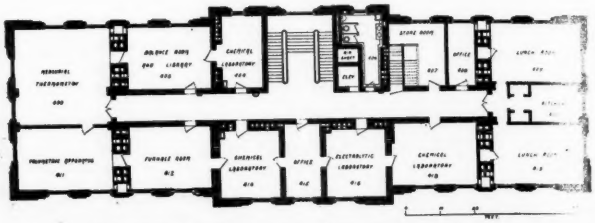
MECHANICAL LABORATORY—SECOND FLOOR PLAN.



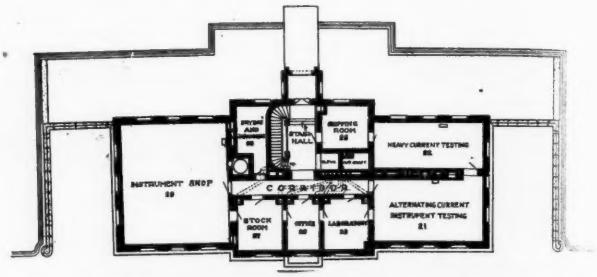
MECHANICAL LABORATORY—ATTIC FLOOR PLAN.



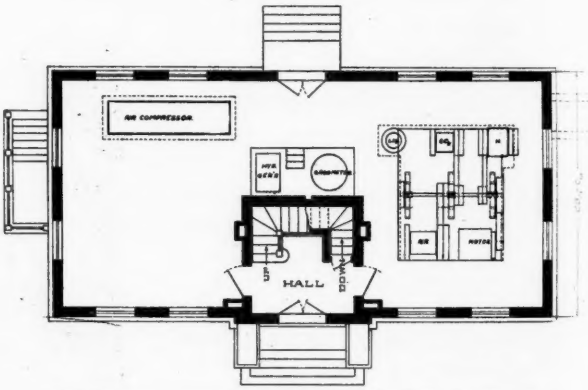
PHYSICAL LABORATORY—THIRD FLOOR PLAN.



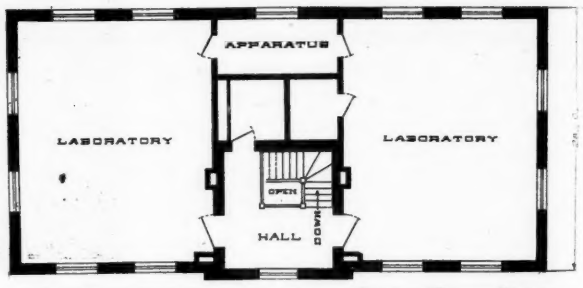
PHYSICAL LABORATORY—FOURTH FLOOR PLAN.



MECHANICAL LABORATORY—FIRST FLOOR PLAN.



LOW-TEMPERATURE LABORATORY—FIRST FLOOR PLAN.



LOW-TEMPERATURE LABORATORY—SECOND FLOOR PLAN.

and complete control over the various possible combinations.

The switchboard shown herewith not only controls the various direct and alternating-current generators, but also six storage batteries arranged in groups of two on the three-wire system, for use in operating the motors when great steadiness of speed is desired, for lighting and power when the engines are not running, and for experimental purposes. There are also several plug-panels which enable the current from any generator or battery to be sent to any laboratory room in either building.

eighteen feet, and contains a thirty-ton ammonia refrigerating machine of the absorption type. Its capacity is equivalent to the melting of ten tons of ice in eight hours. This is used to furnish low temperatures in small rooms for experimental purposes, to remove moisture from the air of laboratory rooms in order to obtain a dry atmosphere in hot or wet weather, and for making ice. The machine is indispensable, and greatly increases the efficiency of the laboratory work, more especially, of course, in the summer; but it is found necessary to use it for some kinds of work part of the time during at

hottest and dampest summer weather. Moreover, the temperature of the laboratory may be controlled at the same time, the gradual rise of temperature during the day being prevented. The rate of absorption of heat may be regulated by varying the speed of the fan which blows air against this cold brine coil.

A large tank of calcium chloride brine in the subbasement under the refrigerating room gives a considerable storage capacity for "cold," and avoids the necessity of running the machine every day except in summer.

The storage-battery room is sixty-one

THE ENGINE ROOM, MECHANICAL BUILDING—NATIONAL BUREAU OF STANDARDS.

In the foreground, at the left, is shown part of a motor-driven exhaust-fan for withdrawing fumes from the battery rooms and other rooms of both buildings.

In the subbasement, under the engine-room floor, are located the high-pressure steam mains, exhaust-steam pipes, air-ducts, water, gas and other piping, and the wiring. This gives an engine room practically free from piping, affording free travel for the crane and giving a very pleasing appearance.

The refrigeration room is forty-one by

least nine months of the year. The cold brine is pumped from the machine through a system of piping around both buildings, so that it may be used in almost any of the laboratory rooms. Flowing through a coil of pipe in any room, it condenses moisture out of the atmosphere and reduces the humidity from 100 or ninety or eighty per cent to perhaps seventy or sixty or fifty per cent, according to the surface exposed. Thus electrical surface leakage may be so far reduced that precision measurements may be made in the

feet long and contains the following chloride cells: four batteries of sixty-six cells each, 200 ampere-hours capacity; two batteries of sixty-six cells each, 400 ampere-hours capacity.

Two additional batteries of the 400-ampere size will probably be installed next year.

The heating and ventilating plant is located near the engine room, as shown in the basement floor plan.

The forced draught, double-duct system is used, with thermostatic dampers to con-

trol the proportion of hot and tempered air in each room so as to secure constant temperature. This is effective in cool weather; in hot weather the temperature of the laboratory rooms may be controlled by means of the brine coils. Two large motor-driven blowers stand in the basement hall, at the entrance to the tunnel, one handling the hot air and the other the tempered air. The second may receive cooled air (in hot weather) from the cooling chamber, which contains a large number of brine coils. The hot and tempered air for the physical building passes through ducts in the upper part of the tunnel to the basement of the physical building, and is there distributed through the flues shown in the floor plans to the various rooms. The air is heated by passing through stacks of steam-coils, the steam being for the most part the exhaust from the engines.

Refrigerating Room—National Bureau of Standards.

THE LOW-TEMPERATURE BUILDING.

The low-temperature building is being erected to accommodate the machinery and apparatus necessary for the liquefaction of air, hydrogen and other gases, and to provide space and facilities for low-temperature experiments. The building is about twenty-eight feet by fifty-eight feet, and two stories high, being built of dark-red brick, trimmed with limestone to correspond with the main buildings. It is connected with the subbasement of the mechanical laboratory by means of a tunnel, through which water, gas, steam and waste pipes and wires are carried. The bureau purchased from the British government a complete plant for the liquefaction of air and hydrogen; this was built in London and exhibited last year at the St. Louis exposition. The apparatus consists of a hydrogen generator and gasometer for storing the gas, power pumps for compressing air and hydrogen to 3,000 pounds per square inch, and heavy cylinders for storing hydrogen at this pressure, a combined air and hydrogen liquefier, and a machine for liquefying carbon dioxide, which is used as an auxiliary refrigerant in the process of liquefying air. In liquefying hydrogen, both liquid CO_2 and liquid air are employed as auxiliary refrigerants, the compressed hydrogen being thus cooled to the temperature of liquid air and then suddenly expanded, and thereby suffering a reduction of temperature sufficient to liquefy a portion of the gas. The liquefied hydrogen may be frozen in a separate apparatus, its temperature being reduced to about sixteen degrees absolute.

This is the only apparatus in America for liquefying hydrogen, and we believe the only one outside the Royal Institution of Great Britain for producing liquid hydrogen in considerable quantities; that is, by the litre. It will be of great service to the bureau in research work and also in the testing of low-temperature thermometers. In the near future a second air compressor of larger capacity will be installed and a second liquefier for air will be added.

PIPING AND WIRING OF THE PHYSICAL BUILDING.

The physical building is 172 feet long, fifty-five feet wide and four stories high, besides a spacious attic. It faces the south overlooking the city of Washington.

The corridor extends the entire length of the first floor. The exterior of the building is so designed that the two additional buildings, which may in the future be placed one on the east and the other on the west of this building, may be connected with it by means of an arcade opening into the corridor of the first floor. A basement is excavated only under the central portion of the building and under the corridor; the four rooms at either end of the ground floor have concrete floors resting on the ground, covered by a substantial flooring of oak blocks. This gives a firm support for tables, apparatus or even temporary piers if necessary.

Instead of building up permanent piers through the floor, as is often done, the entire building is so substantial and free from vibration that the most delicate apparatus can be mounted on brackets or shelves attached to the walls of the building.

In one of the basement rooms a subdivided storage battery has been installed for use in this building. Six other rooms of the basement will be used as constant temperature rooms as they may be needed.

The entire first and second floors are given up to laboratory work. And in order that the changes in temperature may be a minimum, double windows have been provided, and automatic temperature control secured by means of thermostatic dampers, controlling the supply of hot and tempered air. This, of course, regulates the temperature only in winter, or in cool weather; in summer the temperature is controlled in some rooms when necessary by means of brine coils, as explained above.

Between rooms 101 and 102, next to the outer wall, is a vertical shaft three feet square, extending from the basement to the attic, and in corresponding positions there are three similar shafts in the other three quarters of the building. All the pipes for distributing hot and cold water, ice water, cold brine, gas, compressed air, vacuum, and all electric wiring for lighting and experimental purposes are carried up through these shafts. A door opens into each shaft on each floor, making all main pipes and wires accessible without having them exposed in the laboratories. On each floor branches are brought out from the water and waste pipes to the sinks, from the air and gas

pipes to the work tables, from the brine pipes to any cold boxes or other apparatus requiring it and from the distributing wires in the shafts to the small local switchboards, of which there is one for each suite of laboratory rooms in the building. The wires connected to these small switchboards run to a main switchboard near the north door of the first floor, and thence trunk lines run through the tunnel connecting the two buildings to the main distributing switchboard of the dynamo room. Thus through these two main switchboards and a local laboratory board, any circuit in any laboratory room may be joined to any circuit of any other laboratory room or to any battery or generator in the mechanical building. By means of a subdivided battery wired to the switchboard and an autotransformer at the switchboard, any direct or alternating voltage less than the regular line voltages (120 and 240) can at any time be obtained.

Great pains have been taken to equip every laboratory with the conveniences necessary for the most efficient work.

INSTRUMENT SHOP.

An instrument shop, equipped with suitable machinery and provided with expert mechanicians, is an essential feature of any laboratory; this is especially true in institutions where precise measurements and original investigation constitute the greater part of the work. The shop of the bureau is equipped with modern machinery, each machine separately driven by an electric motor. It is both an instrument shop and a machine shop, capable of handling a wide range of work. A supply of metal sheet, rod, tube and wires, as well as a great variety of other materials used in the construction of apparatus, is kept in stock. The mechanicians have been carefully selected, both as to personal and technical qualifications; they have been trained in the best American and foreign instrument shops.

A system of apprenticeship has been established. The apprentices are graduates of manual training and technical high schools, thus assuring the fundamental education necessary in this class of assistants, and so often lacking in men who have been trained in commercial shops.

At the anniversary meeting of the Royal Society, held November 30, at London, England, Professor Augusto Righi was awarded the Hughes medal for his experimental researches in electrical science, including electric vibrations.

Some New Lines of Work in Electrotherapeutics.

In a lecture delivered recently before the Hunterian Society, of Great Britain, Dr. H. Lewis Jones discussed some new lines of work in electrotherapeutics, which are most interesting and encouraging. The author has been earnestly engaged in this branch of therapeutics for about fifteen years. During these years great changes have taken place in the applications of electricity to medical work. The widespread distribution of electricity for lighting and other purposes has rendered possible the utilization of it on a scale which would have been impossible in former days. These modern facilities for obtaining supplies of current would not, of themselves, have altered the aspect of electrotherapeutics, had there not always been a few medical men who were attracted to the study of the science of electricity for its own sake, and by a recognition of its therapeutic possibilities. As a matter of fact, the medical profession has never been slow in seeking to apply new scientific discoveries to medical uses. Although there have always been a few patient workers in the field of medical electricity, it is nevertheless the case that among the rank and file of the profession, the interest excited by electrical methods of treatment has been slight. To those who judged merely by results, the field seemed to be a barren one; and so long as electricity was used in medicine mainly for the relief of states of debility, for the treatment of chronic paralytic affections, and for old rheumatic cases, one could understand this attitude. The results from electrical treatments in those morbid conditions were of the same order of merit as those afforded by change of air, by seabathing, or gymnastic exercises; and as they entail more trouble for their administration, they failed to attract the busy practitioner. Electrotherapeutics could not thrive so long as it served merely as a useful adjunct or accessory to other modes of treatment, but it has now made many forward strides, and is becoming able to take a leading part in the treatment of many morbid states.

If any method of treatment is to command the general attention of the medical profession it must be able to render services which are superior to any which can be had from already tried and older methods; and further, it should apply to conditions of disease in which relief is urgently needed.

The eagerness with which the Rœntgen rays were taken up by the medical profession as soon as they were discovered may be adduced as a further proof that electrical methods will never suffer from neglect if they are capable of giving first-class results.

The history of medical electricity has been a history of gradual progress by the method of trial and error—empirical, for the most part, though based on physics and physiology; and while there has been much chaff, there has also been a harvest of grain. If we review for a moment the benefits which medical science has gained from electricity, confining our attention to those things only in which the advantages of electricity are incontestable, we shall see that the list is a goodly one. The names Duchenne and Remak may be made the starting point, their work having been the inauguration of modern methods of application of battery currents, between the years 1850 and 1860. The evolution of a systematic method of procedure for the examination of nerves and muscles by Erb during the succeeding ten years forms the next landmark. Owing to the exactness of its diagnostic results, this section of electrical work has been one of the most precious gifts of electricity to medicine. The principles of electrical testing in paralytic disorders are universally accepted, but the anatomical knowledge, which is needed to form the basis upon which the diagnosis of nervous disorders is built, has been something of an obstacle to the general adoption of electrical testing by the profession at large.

The invention of the incandescent lamp has given medicine some instruments which are quite indispensable. Even before the carbon filament was invented, the advantages of the electric lamp for purposes of medical diagnosis had been realized. Nitsche used tiny loops of platinum wire in his early cystoscope, and although he experienced endless vexations through the fusion of the wire filaments, yet he was so convinced of the value of the electric-exploring lamp that he persevered in the face of all difficulties until the invention of the carbon filament provided him with a satisfactory solution of the problem.

Electrolysis, as a means of destroying certain classes of nævi and for removing hairs and small moles, may also be given a place in the list of first-class matter contributed to medical practice by electricity.

The short list of matters just mentioned represents the position of electricity in medicine down to the time of the dis-

covery of the Rœntgen rays. Although all reference has been omitted purposely to what may be called second-class matter, it by no means follows that there was no good thing among all the other applications of electricity to medical treatment. For the present purpose the lecturer limited his remarks solely to those advantages of electrical methods and practice which admit of no question.

The discovery of Rœntgen rays increased the claims of electricity to proper recognition. The demands for X-ray apparatus have kept the instrument makers busy from that time to this, and the developments of the therapeutic uses of X-rays, as well as the diagnostic uses, have had the effect of overshadowing the rest of the applications of medical electricity, so that they have been in danger of being forgotten by the general mass of the profession. The list of real gains in X-ray therapeutics is large and highly important. Passing by the question of malignant disease, in which, nevertheless, X-rays may be of considerable value in prolonging life, we yet find a goodly list which may be confidently claimed as conditions in which X-rays give results of great value.

The Finsen treatment of lupus, which may be claimed as a distinct gain, and may be credited to electricity, though, as a practical method, it labors under the disadvantage of extreme cost and extreme slowness of operation.

As the field of electrotherapeutics goes on growing, and as it continues to embrace the treatment of the more serious disorders which affect humanity, less and less is seen of the unqualified electrician. When the relief sought for is of the nature of tonic or invigorating effects, or the easing of a little rheumatism, the man with the electrical machine is considered sufficient for dealing with matters of such relative importance. Anatomical and medical knowledge is needed for electrical testing and diagnosis, and the unqualified man does not possess it. X-ray photography is rapidly becoming too difficult for him, and X-ray treatment too dangerous. High-frequency has already shrunk to its proper dimensions. The light bath—red, white and blue—is destined to become a more or less ornamental accessory in Turkish-bath establishments, instead of being relied on as a panacea for all kinds of painful and other affections. In spite of all the striking advances which have been made in the field of X-ray therapeutics, the older field of work with the so-called galvanic and faradic currents has not been exhausted. For example, the subject of electrolysis has recently come into prominence afresh, not for the destructive actions which it exercises in its application to nævus, but as a means of introducing drugs into the system, and also, perhaps, for the withdrawal of injurious chemical objects from the system. This use of electrolysis is not entirely novel. Something may be found upon the subject in most of the older textbooks on medical electricity, but, of late, a better comprehension of the physical laws of electrolysis is leading to new medical applications, which promise to be useful.

The introduction of drugs into the living body by electrolysis is far more complicated than their administration by the mouth or hypodermic injection, and it must have some corresponding advantages if it is to be adopted in medical practice. For purposes of local medication there might be a field of employment for electrolytic medication, although for general medication its use would be of no practical advantage. But even for local medication the method must be able to compare advantageously with the method of subcutaneous injection, of fomentation, or of inunction. In theoretical support of the electrolytic method it may be pointed out that whereas a hypodermic injection passes into the interstices and lymph spaces, and may never reach the actual cells, the ions introduced electrically must enter into the composition of every cell through which the current passes, at least in those portions which are in close proximity to the active electrode; and by reason of that penetration they may be enabled to act more effectively and for a longer time before they are carried off with the general circulation of the lymph stream. The amount of penetration which follows fomentation or inunction is rarely of great use in medication.

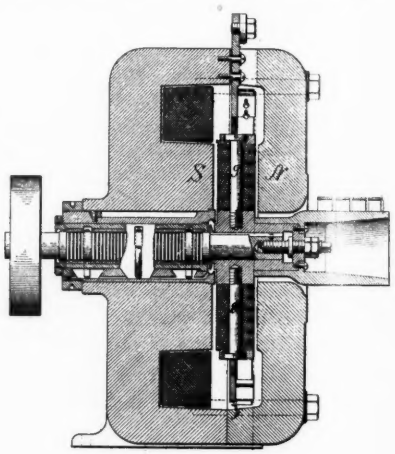
Dr. Jones described his own work in treating rodent ulcers electrolytically. The first case treated gave what appeared to be a complete cure, and after nine months there was no return of the disease. Seven cases altogether of rodent ulcer were reported upon. In all of them the results seem to be favorable, and the work is considered most encouraging. To obtain a successful effect requires an evenly distributed action of the zinc over the whole area of the ulcer, and in many cases this is rendered difficult. In ordinary cases the distribution is unequal, so that certain portions of the ulcer receive a better quantity of the zinc than others.

The effect of this treatment on lupus is not yet fully determined. Dr. Jones is trying the method in several cases, and the partial results obtained are not discouraging. He still hopes for a successful method of treating this disease, using zinc, or, perhaps, copper.

The possibilities which this field of work seems to open are highly attractive, but much patient work will be necessary before we can claim anything like final results. There is room for many workers in this new line.

Electrical Patents.

Henry H. Wait, of Chicago, Ill., has obtained a patent (806,217, December 5) for an improved dynamo-electric machine. The invention relates to a dynamo-electric machine, and more particularly to a machine of the general type known variously as "unipolar," "homopolar" or "acyclic." Machines of this kind are designed to be driven at high speeds, and are therefore especially adapted to be direct-driven by turbine engines. The object of this invention is to provide an improved construction of the rotor or armature by which the efficiency of the machine may be increased. The invention consists in the combination with a magnet having pole-

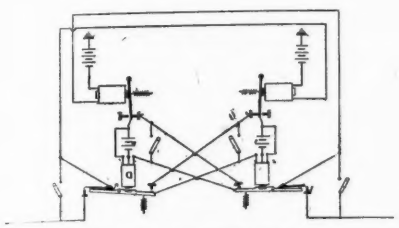


Dynamo-Electric Machine.

pieces arranged to establish a unidirectional field of force, of an armature arranged to move within this field, a magnetizing winding for the field, conductors carried by the armature adapted to have currents induced therein by passing through the field, the conductors being inclined to the direction of their motion through the field, whereby the currents through the conductors establish a magnetic flux coacting with the field flux, and means for collecting the current and externally completing the circuit between the terminals of the moving conductors.

Oscar C. Greene, of St. Paul, Minn., and Charles H. Gaunt, of Topeka, Kan., have obtained a patent (806,801, Decem-

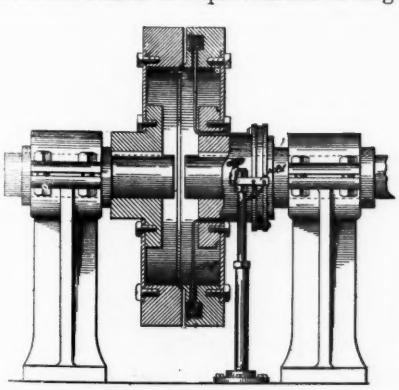
ber 12) on an improved telegraph repeater. The invention relates to improvements in telegraph repeaters, its object being to simplify, improve and increase the speed and efficiency of operation of the repeating apparatus, by means of which messages are automatically repeated



TELEGRAPH REPEATER.

or transferred from one telegraph circuit to another. To this end, there is provided in each circuit, in connection with an ordinary relay, a repeating sounder having a magnet so wound, energized and connected directly with the opposite repeating sounder that the lever of the repeating sounder on the outgoing side will not operate to open the circuit on the incoming side. The repeating sounder on the outgoing side thus comprises within itself the means of controlling directly the action of the repeating sounder on the incoming side, and makes it possible to dispense with all auxiliary or additional magnets, levers, batteries and apparatus designed to accomplish this purpose indirectly, as by acting upon the relays.

George A. Damon, of Chicago, Ill., has obtained a patent (806,782, December 12) on an improved magnetic clutch, which he has assigned to the Arnold Magnetic Clutch Company, Milwaukee, Wis. The invention relates to improvements in mag-



MAGNETIC CLUTCH.

netic clutches. Heretofore, in devices of this character, if one of the members should be set or accidentally sprung so that its meeting face was out of alignment with the face of the opposing member, but a portion of the two meeting faces would be in contact and therefore an undue strain would be produced upon the parts and the clutch would not efficiently perform its work, and slippage would result. This is very likely to occur in clutches which have their members mounted upon the opposing ends of separate shafts which have their axes aligning. To overcome this is one of the objects of the present invention. The invention consists in the combination with coacting members having corresponding meeting faces normally slightly separated from one another, of a yielding spring support for at least one of the members arranged when the device is clutched to permit the face of the spring-supported member to conform to the face of the other member and to instantly unclutch the device when the magnet is deenergized.

An improvement in a joint for electric conductors has been invented by Austin Fleeger, of Chicora, Pa. (806,789, December 12). This invention relates to joints for electric conductors, and has for its object the provision of a simple and inexpensive joint for the meeting ends of such conductors, which joint may be readily and quickly formed or applied at

JOINT FOR ELECTRIC CONDUCTORS.

a minimum of expense, and which will not only firmly unite and hold said meeting ends, but also improve the conductivity of the joint by avoiding undue resistance and loss of current. A joint for electric conducting wires, comprising aligned wires provided with enlarged terminal portions, and a sleeve of ductile conducting material enclosing the enlarged portions, extending beyond them, and having its extremities swaged down so as to firmly grip the straight portions of the wires, and present continuous internal annular shoulders forming abutments, which resist longitudinal separating movements of the wires.

Electric Tramways in Vigo.

Consul Harmony, of Corunna, Spain, writes that a scheme, which is likely to be accepted, has been proposed by Mr. Emilio Montenegro, of the Bank of Vigo, Spain. This comprises five lines of tramway and one side line, making altogether about fourteen kilometres, for which the trolley system will be adopted. There will be thirty-nine motor carriages and traction cars, each motor car accommodating thirty-two passengers, and each trailer car twenty-four passengers. There will be two principal and two auxiliary stations. Current will be furnished by the gas company, which has a plant located on the falls of the river Lerez. Particulars can be secured from E. Mulder, consular agent at Vigo.

A Society to Promote the Art and Science of Illumination.

A preliminary meeting of men interested in the art and science of illumination was held at the Hotel Astor, New York city, Thursday evening, December 21. The object of the meeting was to consider ways and means of forming a society of men actively interested in this work, so as to bring about cooperation between them and the electrical and gas engineers, the architects and the designers of electric light and gas fixtures. It is hoped that the formation of the society will secure many interesting and valuable papers on illuminating topics; that it will make possible the gathering of authoritative data on lamps, lighting and illumination, and will start a special library covering this field. It is hoped also that the society will be able to cooperate with other societies so as to bring about the standardization of methods of measuring light and illumination and of lamp ratings. Another important matter needing attention is that of nomenclature of illuminating terms.

After an extended, but satisfactory, discussion of the matter, a committee of seven was appointed to report upon a constitution and by-laws, a name for the society and to nominate officers. This committee consists of Mr. L. B. Marks, chairman; Messrs. Charles Browne, E. L. Elliott, W. S. Kellogg, V. R. Lansingh, W. S. Howell and W. D. Weaver. A meeting is to be held on January 4, at which time the committee is to report. It is expected that at this meeting a definite organization will be consummated. About one hundred persons have already signified their intention of becoming members. The meeting, it is anticipated, will be held at the Edison auditorium, 44 West Twenty-seventh street, New York city.

A list of those present at the preliminary meeting follows: Waldo S. Kellogg, of Carrere & Hastings; W. D'A. Ryan, General Electric Company; A. D. Page and F. W. Wilcox, Edison Lamp Works; Major E. L. Zalinski, Dr. C. H. Sharp, Wilson S. Howell and Preston S. Miller, of the Electrical Testing Laboratories; Charles A. Barton, Nernst Lamp Company; J. S. Codman, Boston, Mass.; O. A. Mygatt, president of the Holophane Glass Company, and V. R. Lansingh, H. M. Lauritzen and A. A. Ernst, of the same company; Arthur Williams, A. A. Pope, Walter R. Boyd, E. A. Norman, Charles K. Nichols and John Lloyd Prince, New York Edison Company; F. N. Olcott, of Black & Boyd; E. L. Elliott; L. B. Marks; Louis Wiley, of the New York *Times*, and William Hand Browne, Jr., ELECTRICAL REVIEW.

Reviews of Current Engineering and Scientific Literature.

The Mesophotometer for the Direct Measurement of Luminous Flux from Luminous Sources.

There are two types of apparatus available for the measurement of luminous flux, and thus determining the mean spherical candle-power of a source of light. These are so-called lnmin meters. and the mesophotometers. Instruments of the first class produce a lighting of the photometer screen proportional to the total flux given out by means of diffused rays. Mesophotometers, on the other hand, use reflectors for the same purpose. M. C. Léonard in this article discusses briefly the theory of the mesophotometer, as proposed by Blondel, and describes the construction. It consists of a series of plane mirrors arranged around the source of light so as to reflect the rays given out by it in a converging cone, throwing them upon the photometer screen. In order to reduce the amount of light reflected by the mirrors, so as to make it proportional to the area through which it is radiated, a screen is interposed between the photometer and the light. This screen, as first proposed, consists of a band carried forward at right angles to the axis of the cone, and perforated with a series of circular openings tangent at the centre of the band. This arrangement allows the various rays of light to fall upon the screen for a length of time proportional to the area of the zone through which they are radiated. The arrangement of an endless band, as here proposed, is not always convenient, and it is desirable to replace it by a circular screen rotated about its centre. This may be done when the openings in the screen are of the proper shape. M. Léonard shows how these openings should be computed. They are in form rather like a flat top. The instrument described is suitable for use on all sources of light.—*Translated and abstracted from L'Éclairage Électrique (Paris), December 2.*

The Falling to Pieces of the Ions.

A summarization is given here by Miss Lulu B. Joslin of some recent investigations into the break-up of atoms. The method used was the production of fog in dust-free, moist air, due to the rays thrown off from a weak sample of radium enclosed in an aluminum tube. The results were plotted in a graphical form, and the assumption was made that the nuclei are produced faster than they can be removed by the exhaustion of air from the fog chamber. It appears from the curves that in the presence of radium, under the conditions observed, the number of efficient nuclei decreases, either because the ions, from their size, capture all the available moisture more and more fully, or because the colloidal nuclei have actually been aggregated into fewer, but larger, systems. Inasmuch as the radiation within the fog-chamber is largely secondary, a corresponding pressure due to the corpuscles must exist, and this would have a tendency to produce agglomeration, and would explain why the X-rays and the ultra-violet light produce fleeting and persistent nuclei alike in kind, except that only the former are ions. Above the fog limit of dust-free air the number of efficient nuclei must increase with the removal of the radium at a rate which corresponds to the falling to pieces of the ions. A peculiar feature of the results is the manner in which the efficient nucleation decays from the coarser ions to the finer non-ionized colloidal stages, and the pressure difference is decidedly above the fog limit of air. The curves invariably pass through a minimum when the time after the removal of the radium increases indefinitely. This minimum is sharp, almost cusplike, as if one law were passing abruptly into another. The curves obtained resemble some obtained previously by Barus, showing the effect of radium at different distances from the fog chamber, indicating that the same cause underlies both series of observations.—*Abstracted from Science (New York), December 8.*

Standards of Mutual Induction.

In magnetic tests of iron a standard of mutual inductance is frequently used as a means of standardizing the ballistic galvanometer. For satisfactory use, the value of this standard of mutual inductance should be accurately known. In this article Messrs. G. F. C. Searle and J. R. Airey discuss the best method of construction and of computing the value of the standard. An approximate calculation of the mutual inductance may be made, using Kelvin's arrangement. Here the primary coil is uniformly wound on a circular cylinder, the length of the coil being great in comparison with its diameter. The secondary coil is of thin wire, which is wound on the outside of the primary coil on an accurately measured cylinder placed within the cylinder carrying the primary, and coaxially with it. The length of the secondary coil is small in comparison with that of the primary. A theorem proposed by Jones states that if there be any circle with its centre on the axis of the cylinder, and its plane perpendicular to the axis, the number of lines of force which pass through the circle and are due to the circuit containing the helix, is the same as the number which pass through the circle, and are due to a uniform cylindrical current sheet of the same radial and axial dimensions as the helix, if the currents per unit of axial length in helix and sheet be the same. This assumes that the primary wire is infinitely thin, but a uniform helix of finite thickness can be split up into helical filaments, and hence the current in the helical wire of finer thickness can be replaced by a system of currents flowing in the space between the two cylinders which touch the helical wire. The exact distribution of current in this space depends upon the distribution in the wire, and this is not easy to settle. The shape of the wire may be changed when winding it, and the resistance may be affected. It may be assumed that the thinner the wire the more nearly may the current in it be replaced by the infinitely thin sheet. In actual standards of mutual inductance there are two helices, and hence Jones's theorem is not strictly applicable; but when the secondary coil is wound with very fine wire, so that the number of turns per centimetre is several times the number per centimetre on the primary, the mutual potential energy will be very nearly the same as if the current in the secondary were replaced by a current sheet, especially if the distance between the primary and the secondary is several times the pitch of the primary helix. The authors then discuss the problem analytically, and show what corrections are necessary. It was found that the error due to non-centering of the inner coil is small. A practical form of standard mutual inductance is described. It is essential that there should be an integral number of turns on both coils. The connecting wire should be carried parallel to the axis of the coils. The coils must be wound on non-magnetic material, preferably non-conducting material, as they may then be

used for alternating currents. Marble is the best substance for this. In order to secure an even distribution of the wire it should be wound into helical grooves cut in the cylinders.—*Abstracted from the Electrician (London), December 8.*

Wattmeter Methods of Measuring Power Expended upon Condensers and Circuits of Low Power-Factor.

Methods are described here by Dr. E. B. Rosa, which he has used for measuring the power expended upon condensers. When the power-factor of a circuit is low it is difficult to measure the power accurately, since the simple wattmeter method involves two corrections—one for the power expended on the fixed coil of the wattmeter and one for the change of phase of the potential current, due to the combined inductance and capacity of the potential circuit. The correction, which is chiefly due to the inductance of the coil of the instrument which carries the potential current, is made small by using a large resistance in the potential circuit, such, for example, as incandescent lamp filaments. The potential current being made small requires that a relatively delicate suspension be employed to give a satisfactory deflection. Difficulty has been found in securing sufficient stability and sensitiveness at the same time, and this has led to a series of null methods for measuring the power-factor of a condenser or cable current. This avoids the measurement of deflection, and dispenses with the requirement of good stability. The most obvious null method consists of using a variable inductance in the potential circuit, the difference of phase between the two currents being nearly ninety degrees. If the potential current is slightly retarded by an added inductance, the phase difference can be made ninety degrees, and the deflection reduced to zero. Knowing the value of the added inductance, the frequency of the current and the resistance, the change of phase, and hence the power-factor, can readily be computed. There are several other methods of getting a difference of phase of ninety degrees. These all depend upon the use of an auxiliary coil of fine wire wound over the fixed coil of coarse wire, having about the same number of turns as the fixed coil, and made exactly equivalent to the fixed coil magnetically. This equivalence is shown by causing the same current to flow through the main and the auxiliary coil in opposite directions. When a balance is secured there is no deflection of the suspended coil. The compensation current may be secured in several ways. It may be taken from the terminals of a non-inductive resistance in the main circuit, the auxiliary coil being connected in shunt, and having a second condenser in series with it. A portion of the potential current may be shunted off through the auxiliary coil, or by transforming down from the high electromotive force impressed upon the condenser a small electromotive force is obtained, differing almost exactly by 180 degrees. The author then describes the application of the various methods proposed, and concludes that each of the methods requires the determination of three or four quantities, so that a choice of method will be determined in part by the facilities available for the work. They are all capable of giving good results, but the null methods are more satisfactory than the deflection method. It is suggested that by keeping careful note of the temperature of the condensers, and determining accurately the frequency of the current and the exact value of the two corrections mentioned, a crucial test of the various methods may be obtained. The results of measurements on a number of condensers are given, the power-factor being, in all cases, approximately one-half of one per cent.—*Abstracted from the Bulletin of the Bureau of Standards (Washington), November.*

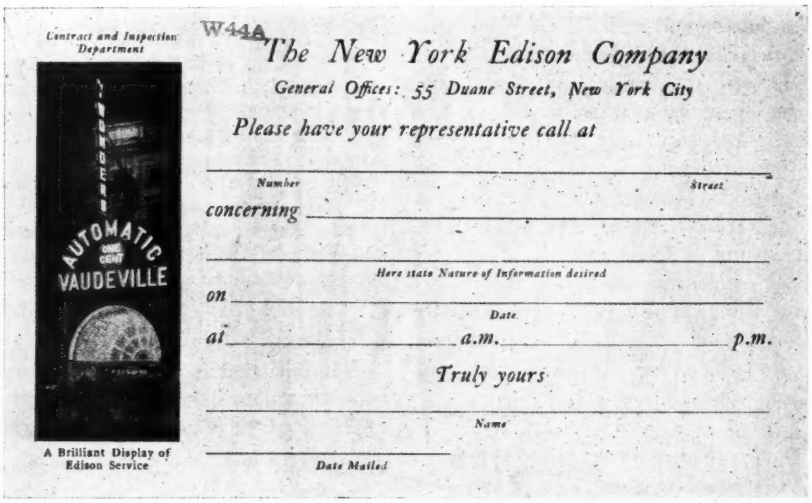
The Fixation of Atmospheric Nitrogen.

An abstract is given here of a recent French paper by M. A. Boileau, on the fixation of atmospheric nitrogen. In addition to several other methods, four making use of electrical power in some way or other have been tried. One of the most promising was that due to Frank and Caro. The original process consisted in raising powdered barium carbide to redness in a muffle furnace, and then passing a current of nitrogen over it. Thirty per cent of the carbide was thus converted into cyanide, and the rest into cyanamide, with separation of carbon. The product contains about eleven per cent of nitrogen, when the original carbide is eighty per cent pure. On fusing the mass with soda, the cyanamide is converted into cyanide, and on lixivating the melt a crystallizable solution of sodium cyanide is obtained with a precipitate of barium carbonate, which is ready for reconversion into carbide in an electric furnace. The various operations involve a loss of about fourteen per cent of the nitrogen. The next step in this process was to substitute calcium for the barium. This reduces calcium cyanamide only, the cyanide not being formed, and the calcium salt is ready for immediate use as a fertilizer. A carbide of seventy-five to eighty-five per cent purity, when heated, absorbs from eighty-five to ninety-five per cent of the theoretical quantity of hydrogen, and yields a mass containing lime and carbon, and from twenty to twenty-four per cent of combined nitrogen. This salt, when heated with common salt, is converted into cyanide, giving about thirty per cent strength without any purification. The most economical method at the present time consists in avoiding the preliminary preparation of the carbide. The nitrogen is passed into the furnace, where the carbide is being formed. The product is the same as noted already. The value of the cyanamide itself as a fertilizer has not yet been fully established. The Bradley process, as is well known, consists in establishing small, direct-current arcs between platinum points, the effect being to oxidize the nitrogen of the air. In the Kowalski and Moscicki process an alternating current at 50,000 volts is employed, the discharging points being of aluminum. The process devised by Birkeland and Eyde, of Christiana, differs from the two last mentioned in the use of powerful arcs. There is no destruction of the discharge points, so that iron or copper may be developed. The apparatus is also of such a type that it can be cooled by circulating water. The disadvantages of the electrical processes are that they yield a mixture of nitrites and nitrates, and as the former are harmful to vegetable life, the products are not suitable for agricultural purposes. They might be made so by complete oxidation of the nitrite, but on a large scale this operation does not work well. An absorption of the vapors by water, so as to produce a fifty-five per cent nitric acid, is practically possible, but the products would be too expensive to be sold for manure, and there is some uncertainty whether the proportion of nitrites would be reduced sufficiently. Another important application of nitric acid is in the manufacture of explosives, but this industry requires a very concentrated acid, whereas electrical nitric acid has a strength of fifty-five per cent at the highest. It remains to be seen whether a concentration from its original strength to that of sixty-eight per cent is possible commercially. The outputs of the various methods are given as follows: for the cyanide process, from 175 to 275 kilogrammes of combined nitrogen per horse-power-year of 8,760 hours; the Bradley-Lovejoy process, 126.5 kilogrammes of combined nitrogen; the Kowalski and Moscicki system, from seventy-three to eighty-five kilogrammes of combined nitrogen; the Birkeland and Eyde system, 149 kilogrammes of nitrogen.—*Abstracted from the Electrical Review (London), December 8.*

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

The New York Edison Company makes use, very successfully, of a circular letter and return card, which, though simple in construction, is decidedly effective as a business-getter. One sentence out of this letter is as follows: "Are you aware that this company has reduced the cost of electric current so that every one can now use it at a small outlay?" Another paragraph reads: "We feel sure that this new arrangement of prices will prove of great advantage to our old customers, and make many new ones for us." The letter-heading is in black and red, bearing a caricature on one side of Father Knickerbocker looking through a magnifying glass at a small bill, and on the opposite side there is another caricature of a house servant bearing upon a tray a big incandescent lamp, characterizing the large service received.



A Brilliant Display of Edison Service

In planning any line of publicity, the experiences of those who have been carrying on some definite campaign for some time is of particular value. Out of a large experience there is the possibility of a close analysis which eliminates those practices which do not apply to the territory involved, and creates new uses for those methods which meet with success. One of the problems of central station publicity is the proper use of newspaper advertising. Any light that can be thrown upon this subject is always welcome. The Grand Rapids Edison Company, of Grand Rapids, Mich., has given this matter considerable study. In placing newspaper advertising, the company preferred Tuesday, Thursday and Saturday evening editions, and Wednesday, Friday and Sunday morning editions. The preferred space is the right-hand column of the first page, the upper corner being considered the most desirable. Next to this the choice would be the first column of the third page, next to local news and reading matter.

In addition to its newspaper advertising, however, the company makes use of a definite plan of campaign, and utilizes many forms of publicity. Illustrated booklets are not made use of, but from time to time, with the monthly lighting bills, there have been distributed printed circulars describing special devices, such as flat-irons, Christmas-tree outfits, and "Hylo" and "Meridian" lamps.

The company does not do any house wiring or interior construction work. There are five or six competing electrical construction companies in the city.

As all electrical work done in Grand Rapids is under special permit, issued by the local inspection department, the company has an opportunity of getting a daily record of all such permits issued. In this way it keeps in close touch with all work which may mean a prospective customer. The company has also adopted a system of keeping a record of all building permits issued by the local building inspector, and from the records of the building permits and the wiring permits a follow-up system is conducted which will make the owner or tenant of the building a user of electricity if it is possible to do so by persistent and reasonable arguments.

The practice of free lamp renewals, which was a mooted question only a few years ago, now seems to be more or less definitely settled, many of the companies agreeing to lamp renewals, with various compromises. The Grand Rapids company furnishes free all the regular styles of incandescent lamps for original installation, and all renewals of these regular styles.

The company has a regularly established bureau of information and complaints. The record of all trouble calls and the reports of the inspectors' investigations are kept together.

Advertising letters have not been made use of, the company relying upon its personal follow-up system.

Mr. R. L. Goodale, in a paper read before the third annual meeting of the Colorado Electric Light, Power and Railway Association at Glenwood Springs, Col., September 18, stated that he believed that one of the good fields that can be worked in practically any town is the electric laundry iron. Continuing, Mr. Goodale said, in part:

"A good laundry iron of from five to six pounds can be bought now for from $4 up, and manufacturers are now working along the line of heating units that can be renewed without sending the iron back to the factory.

"If you have a showroom you may find it difficult to get them to come and look at the iron, but just take an iron out on ironing day and install it, and tell them that you want them to try it for thirty days. Explain to them the economies of an electric laundry iron, and at the end of the thirty days show them their bill, and unless it has gone up more than a couple of dollars you will find that you won't have more than five per cent of your irons returned. Sell them at cost, and install them at cost, but get the irons out in commission. They will be used the year around, and any single appliance that you can put out that will bring in from $18 to $24 worth of income a year is a good thing."

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Pittsburgh Transformer Company's 1906 Thawer.

The accompanying illustrations show the thawing transformer for thawing frozen pipes which has been placed upon the market by the Pittsburgh Transformer Company, Pittsburgh, Pa. The thawer consists of a transformer, which takes a small current from the alternating-current 1,100-volt or 2,200-volt line and delivers a heavy current at a suitably low voltage. The standard castings, cores and constructional details have been carefully applied to the design of the thawer, as experience has shown that the use of special forms results in reduced production and delay in shipment.

Referring to the illustrations, the wires No. 1 run from the line to the primary fuse-blocks No. 2-2. The primary leads of the transformer run through porcelain bushings in the backboard, and into the fuse-blocks. Within the transformer is a porcelain terminal block, changing the connection of which adapts the transformer to operation on circuits of approximately 1,100 volts or circuits of approximately 2,200 volts.

Four secondary leads issue from the front of the case and pass to the terminals of the double-pole, double-throw switch No. 4. Throwing switch to left connects the secondary coils in multiple; the transformer delivers thirty-seven and one-half volts, and has a capacity of about 800 amperes. Throwing the switch to the right A, as shown in Fig. 1, places the secondary coils in series, so that seventy-five volts and about 400 amperes are obtained.

The secondary line passes through the choke-coil No. 5, and from there through the heat-indicator No. 3. The terminals No. 7-7 are connected to the cables leading to the frozen pipe. The choke-coil plunger is indicated by No. 6.

The choke-coil consists of several turns of copper rod, and has a laminated iron core supplied with a handle for pushing in and out, thus altering the choking effect to suit the conditions involved. The heat-indicator is simply a short section of lead pipe connected in series with the low-voltage winding in the same manner as a fuse, its temperature being a guide as to the heating of the pipe under treatment.

The backboard is removed from the transformer for convenience and safety in shipment. All connections are tagged, so that it is a simple matter to assemble the parts.

The capacity of the thawer is normally 400 and 800 amperes, but currents considerably in excess of these values may be drawn for short periods. When in service the air surrounding the transformer will probably be at a very low temperature. Under such conditions a temperature in the transformer as high as 100 to 125 degrees centigrade above the air will still be within the usual working limits.

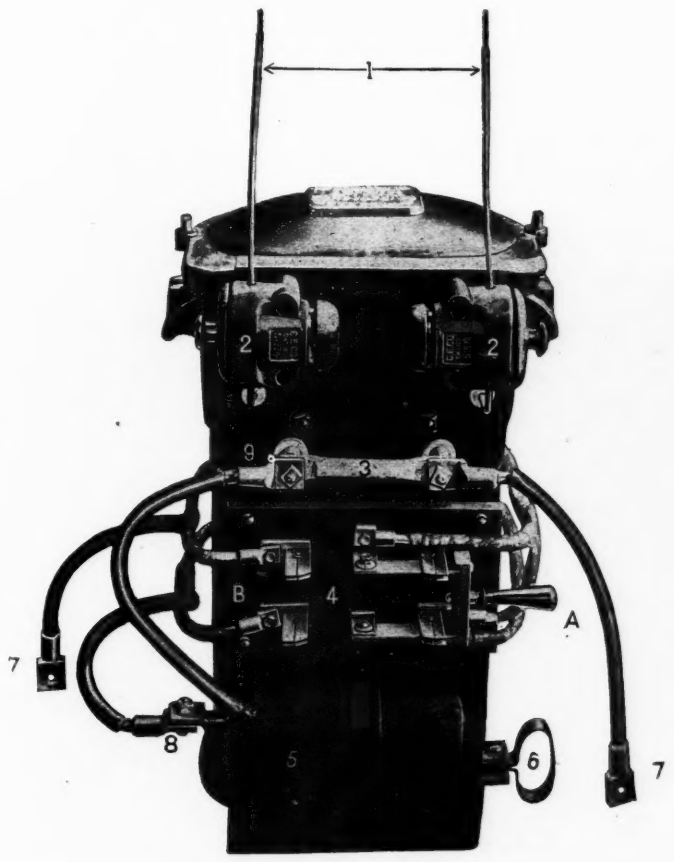


FIG. 1.—THAWING TRANSFORMER.

FIG. 2.—THAWING TRANSFORMER.

The D. and T. Guy Anchor.

A new anchor for guying telephone or electric light poles has recently been put upon the market by the D. & T. Anchor Company, La Crosse, Wis. This anchor is attracting a good deal of attention. The name, D. & T. anchor, is taken from a description of its operations, "D" and "T" being the first letters of the words "drive" and "twist." The anchor, which is illustrated in Fig. 1 and Fig. 2, is driven into the ground with a sledge or maul to a depth of four or five feet. The shaft is then twisted to the right three revolutions by threading the bar through the eye. The revolution of the shaft spreads the blades to an angle of ninety degrees with the shaft. This spreading of the blades is caused by the peculiar shape, which is something like that of the blade of a screw propeller.

Fig. 1 represents the anchor being driven into the ground. Fig. 2 represents the anchor after it has been driven and the shaft has been twisted three revolutions. The photographs from which these illustrations were made were obtained by driving the anchor into the ground and then digging the dirt away from the plane of the anchor to a distance of about six feet on both sides. The illustrations show very nicely the adaptation of the anchor. Fig. 1 shows that the ground is not disturbed to any extent by driving the anchor into the soil, and Fig. 2 demonstrates the holding power which the anchor will have in the undisturbed ground.

The anchor is made up in four sizes, for light work, ordinary work, heavy work, and for dead-ending cables. Size No. 1 is made with a five-eighths-inch steel shaft five feet long, formed into a ring at the top, carrying at the bottom the wings, which are two and one-half inches wide and have a spread of eight inches. They are supported on the shaft by a five-sixteenths-inch pin made from tool steel. Size No. 2 is made with a seven-eighths-inch solid steel shaft six feet long, formed into a ring at the top and carrying at the bottom the two wings, which are two and one-half inches wide and have a spread of eleven inches. These are supported by a five-sixteenths-inch hole in the tool steel pin. Size No. 3, which is recommended for toll-line work, is made with a seven-eighths-inch shaft six feet long, with a bull ring at the top carrying wings which are three and one-half inches wide with a spread of twelve inches. The pin supporting the wings is one-half-inch tool steel. Size No. 4 is the same construction as size No. 3, except that the wings spread eighteen inches. In order to save the stock around the pin, a hole has been made for the pin by spreading the rod in place of drilling the hole. In this manner the entire strength of the heavy shaft is preserved.

The company claims that on account of the unique manner in which the blades are spread, and the depth that the anchor goes into the ground, this type of anchor has very large holding power. The time of installation is also cut down to a minimum.

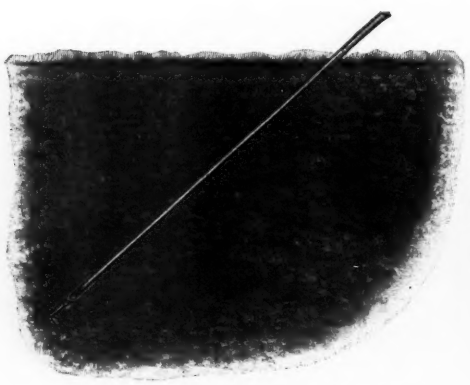


FIG. 1.—GUY ANCHOR BEING DRIVEN.

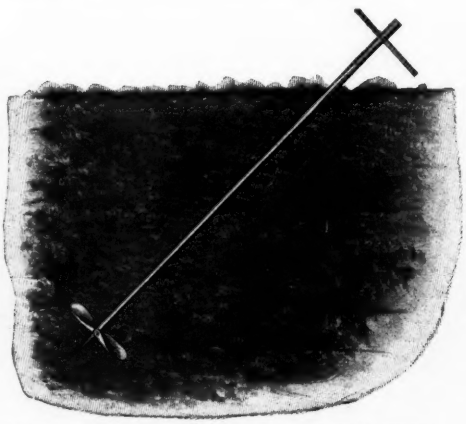


FIG. 2.—GUY ANCHOR SPREAD IN THE GROUND.

The "Sarco" Arc Lamp.

One of the attractions of the recent electrical show at the Madison Square Garden was the "Sarco" light, a type of flame lamp exhibited by the Sarco Company, 906 Sixth avenue, New York city. The Sarco light is termed by its owners as "artificial sunlight," owing to the peculiar golden yellow light produced, which is accomplished by the type of carbon used. The lamps appear to look like the arc lamps as seen in the public thoroughfares, but differ from them materially, particularly in the feed of the carbons. Both carbons are placed at an angle and feed downward from the top of the lamp.

The mechanism of the lamp is simple and durable, and is provided with an automatic cutout, which disconnects the lamp from the circuit whenever the carbons have reached the limit of consumption. The casings are waterproof, and the lamps are furnished with or without enameled iron reflectors, as desired. The carbons in the Sarco light burn from ten to seventeen hours, according to the length being consumed, at a rate of about one inch an hour. Either a white or deep red light can be produced by using other styles of Sarco carbons, although the golden yellow is in most cases preferred. The lamps burn two in series, and the two together use eight, ten or twelve amperes, according to the volume of light desired. Two lamps burning eight amperes give approximately 7,200 hemispherical candlepower "Hefner," and naturally make an extremely efficient form of illumination. In addition to the economy of the Sarco light, it possesses a good advertising feature when placed in store fronts or theatres, and the peculiarly pleasing light effect not alone attract attention but is a decided novelty.

THE NEW "SARCO" ARC LAMP.

The Sarco Company is establishing agencies throughout the United States for the Sarco light.

Some Appleton Specialties.

The Appleton Electric Company, 227 Fulton street, New York city, is the manufacturer of a number of specialties in lightning arresters and arrester auxiliaries. Fig. No. 1 shows the new No. 38 distributing board. This board is furnished with a test plug, which enables one to find a ground without removing any connections. The board is made in twenty-five and fifty metallic lines, and uses No. 8 fuses. As each of the con-

nections is numbered, it is easy to trace all metallic lines.

Fig. No. 2 shows the new No. 601 lightning arrester. This is made in

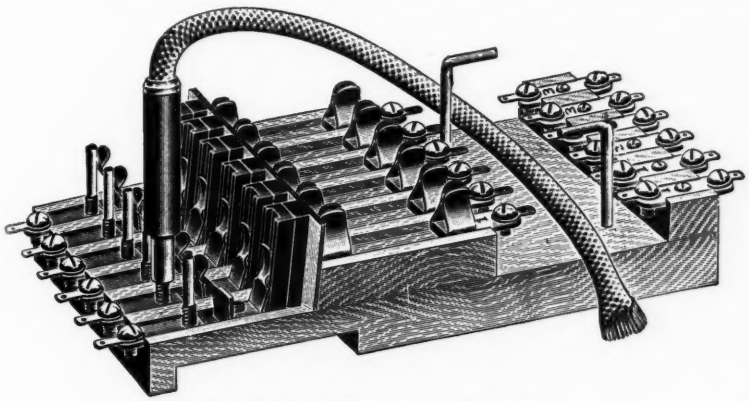


FIG. 1.—NEW DISTRIBUTING BOARD.

Western Union or Postal style, and the open space between the carbons gives the entire carbon surface. There are no mica pieces used. The carbons are adjusted

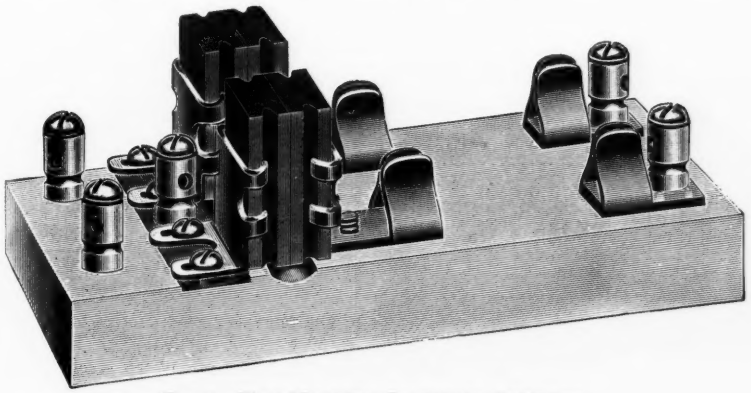


FIG. 2.—NEW MULTIPLE LIGHTNING ARRESTER.

from one-sixty-fourth to one-sixteenth of an inch. It is not necessary to remove the carbons for cleaning, as the insertion of a card removes any dust after lightning

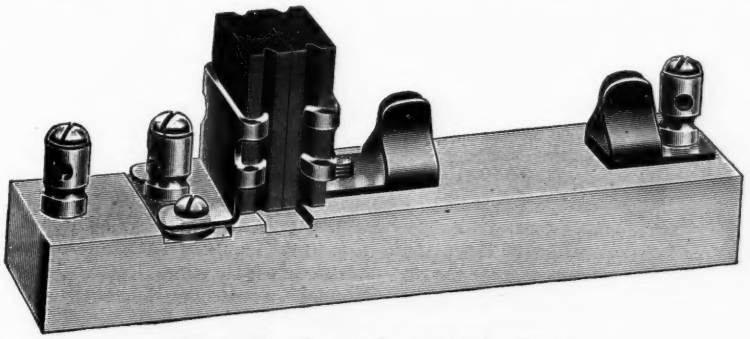


FIG. 3.—NEW SINGLE LIGHTNING ARRESTER.

or a strong current has passed through, and the line is clear. These take a No. 8 fuse.

Fig. No. 3 shows the No. 602 lightning arrester, which is similar to the No. 601, except that it is made up in single units.

The "Knostrain" Socket Bushing.

The Frank H. Stewart Electric Company, 35 North Seventh street, Philadelphia, Pa., has placed upon the market a device for sustaining the weight of a suspended socket and lamp. The National Board of Fire Underwriters, under rule No. 28, section G, demands that the weight of a suspended socket and lamp shall be borne by some approved device which will take the strain from the connections or binding screws, both in the socket and rosette, and at the same time form an insulator or bushing. The device herewith illustrated has been put forth as a solution of this problem. Reenforced, twisted cord is used, with a three-eighths-inch socket, which is arranged with a rosette or handle bushing, which securely grips either No. 16 or No. 18 New Code cord. In Fig. 1 the socket bushing is shown, and in Fig. 2 the handle applica-

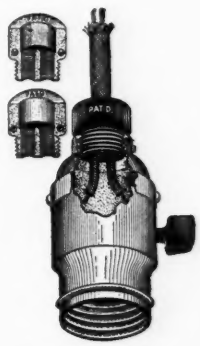


FIG. 1.—SOCKET STRAIN BUSHING.

tion. These bushings are made of composition, are neat in appearance, and the

FIG. 2.—ROSETTE OR HANDLE STRAIN BUSHING.

maker claims that they will neither allow the cord to slip nor work loose.

The Spherical Photometer in Theory and Practice.

Dr. L. Bloch has concluded his discussion of the theory and application of Ulbricht's spherical photometer. In order to test the theoretical deductions, careful experiments were made with the photometer, which were compared with determinations of the spherical candle-power made in the usual way. Next, he investigated the use of the photometer for measuring the mean hemispherical candle-power. This can be done for either hemisphere by placing the sources of light in the plane of the upper or lower surface of the photometer, respectively. The conclusion is reached that this photometer, if it be made with a sufficiently large diameter, may be used either for the direct measurement of the mean hemispherical candle-power, or for the mean spherical candle-power. — *Elecktrotechnische Zeitschrift (Berlin), November* 23.

The Automatic Telephone System at Grand Rapids, Mich.

The following very interesting data has been compiled by C. E. Tarte, general manager of the Citizens' Telephone Company, Grand Rapids, Mich., comparative of the cost of operation in that system of manual and automatic apparatus:

CITIZENS' TELEPHONE COMPANY, GRAND RAPIDS, MICH.

Operating Expense—Manual Exchange.
For year ending December 31, 1903.

Exchange labor (This includes local operators, traffic manager, information clerks, switchboard men and rack man.)	$32,120.28
Inspection department (This includes wire chief, trouble men, trouble clerks and supply boy, but does not include installers and movers. They are kept in a different account, and their time charged to maintenance or construction in accordance with the work done.)	8,039.38
Maintenance wagon and reconstruction wagon (These two were combined in pay-rolls at that time.)	6,648.57
	$46,808.23

There were 4,839 telephones in service at the beginning of the year, and 5,115 at the end of the year, an average of 4,977.
Above departments cost $9.40 per telephone per annum.

Operating Expense—Automatic Exchange.
For year ending June 30, 1905.

Exchange labor (This includes rural operators, traffic manager, information clerks, switching operators, and part of matron's time.)	$3,601.42
Switchboard men (This includes switchboard men and rack man.)	5,981.00
Inspection department (This includes switchboard men and clerks, trouble men and supply man, but does not include installers and movers. They are kept in a different account, and their time charged to maintenance or construction in accordance with the work done.)	10,720.00
Maintenance wagon labor	4,440.00
Reconstruction wagon labor	3,440.00
	$28,182.42

There were 5,605 telephones in service June 30, 1904, and 6,633 in service June 30, 1905, an average of 6,119.
Above departments cost $4.60 per telephone per annum.

The automatic exchange operated an average of 1,142 telephones more than the manual. With the same number of telephones in operation the total cost of the manual system would have been $57,543.03 against $28,182.42 for the automatic—a difference in favor of the latter, on an average of 6,119 telephones, of $29,360.61.

In addition to the above employés in what is called the inspection department, one cable troubleman, and during the month of June there were ten men known as installers and movers. About one-half of the time of the installers and movers is put in in moving telephones, rewiring, changing circuits, etc., and the other half is employed in installing new telephones, and, therefore, one-half of this force is charged to construction and the other half to maintenance.

1 cable troubleman	$60.00	
9 installers and movers, one-half charged to construction and one-half charged to maintenance ($55, $55, $55, $50, $50, $50, $35, $30, $30 = $410)	205.00	
		$265.00
209 rural subscribers.		
2 day rural operators, $25, $25	50.00	
2 evening rural operators, $18, $18	36.00	
		86.00
Grand total		$2,738.00

CITIZENS' TELEPHONE COMPANY OF GRAND RAPIDS, AUTOMATIC EXCHANGE.

Details of Operating Expense for the Month of June, 1905.

6,351 automatic telephones in service June 1, 1905		
Traffic manager, $85 ($40 of this charged to toll traffic)	$45.00	
3 day information clerks, $30, $30, $25	85.00	
3 noon and evening clerks, $30, $25, $20	75.00	
1 number clerk, keeps up number records, etc	28.00	
2 day-switching operators at multiple section, $28, $25	53.00	
1 evening switching operator at multiple section	18.00	
Part of matron's time	15.00	
		$319.00
1 chief switchboard man	85.00	
1 switchman	65.00	
1 switchman	65.00	
1 switchman	60.00	
1 switchman	60.00	
1 switchman	55.00	
1 switchman	55.00	
		545.00
1 rackman	50.00	50.00
1 wire chief	80.00	
1 assistant wire chief	60.00	
1 clerk	40.00	
1 clerk	30.00	
5 troublemen, @ $60	300.00	
6 troublemen, @ $55	330.00	
1 troubleman, @ $50	50.00	
1 supply man	55.00	
		945.00
Maintenance Wagon.		
1 foreman	70.00	
2 linemen, @ $60	120.00	
Wagon and driver	71.50	
		261.50
Reconstruction Wagon.		
1 foreman	65.00	
3 linemen, @ $60	180.00	
Wagon and driver	71.50	
		316.50
		$2,437.00

The Foundation Stone of the New Building of the Engineers' Club Laid.

The foundation stone of the new building of the Engineers' Club, on West Fortieth street, New York city, opposite Bryant Park and the new public library, was laid on December 23, at 2.30 P. M., by Mrs. Andrew Carnegie, whose husband declared the task well and truly done. The ceremony was quite informal, but the club was well represented by its officers and committees, including President W. H. Fletcher and Past-President John C. Kafer. The architects, Messrs. Whitfield & King, were also present. Fortunately the weather cleared during the afternoon, and thus the party were enabled to inspect the building, now up to the ninth story in the steel work and to the third in marble and brick casing. The records deposited in the stone included a Bible of 1905, a club book of 1905, copies of the *Herald, Tribune, Sun* and *Times* of December 23, a copy of the certificate of incorporation, a booklet of the old clubhouse at 374 Fifth avenue, a half-dollar, quarter-dollar, dime, nickel and one cent, a card of W. L. Crow (the builder), a copy of Mr. Carnegie's letter of gift to the engineering societies and the Engineers' Club, a chronological history of the club, a list of members elected since the publication of the club book this year, a list of the incorporators of the club, the programme of competition for the selection of architects for the two buildings, and floor plans of the new house.

The Railway Signal Association.

The next meeting of the Railway Signal Association will be held at the Grand Union Hotel, New York city, January 9, 1906, when the following papers will be presented: "Signaling on the East Bengal State Railway," by George K. Rogers, signal engineer; "The Care of Storage Batteries as Used for Signal Devices," by H. W. Lewis, supervisor of signals, Lehigh Valley Railroad; "Preliminary Report of Installation and Maintenance of Storage Batteries," by I. S. Raymer, chairman of committee No. 4; "Line Wire," by F. F. Fowle, special agent, American Telephone and Telegraph Company, New York city. Chairman Azel Ames, Jr., of committee No. 12, "Rubber-Covered Wire," will take up for discussion the question of the feasibility of a system of inspection for rubber-covered wires. In addition to this an amendment to the constitution and by-laws is to be voted on.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

EXTENDING CABLE LINE—The cable steamship Faraday, belonging to Messrs. Siemens Brothers & Company, having on board 1,750 knots of cable for the Central & South American Telegraph Company, has sailed from Montevideo for Valparaiso, and was due to arrive December 28. The cable is to duplicate the Central & South American Telegraph Company's system between Valparaiso, Iquique, Chili and Callao, Peru.

MEXICAN LIGHT AND POWER COMPANY—The second annual general meeting of the Mexican Light and Power Company showed that the company was now delivering power from its electrical plant at Necaxa to the city of Mexico. The report of the general manager stated that the demand for power in Mexico would always be in excess of the company's supply. The board of directors was reelected, with James Ross, president; J. H. Plummer, F. S. Pearson, New York, and F. L. Wauklyn, vice-presidents.

PHILADELPHIA (PA.) BELL TELEPHONE COMPANY TO INCREASE ITS CAPITAL STOCK—The directors of the Bell Telephone Company, of Philadelphia, at a meeting on December 22, decided to recommend to the stockholders an increase in the capital stock of the company from $16,000,000 to $30,000,000. The stockholders will vote on the proposition on February 20. If the recommendation is approved, the new stock will be offered to stockholders from time to time, in proportion to their holdings, in such amounts as the requirements of the business may demand.

POWER PLANT ON THE BROAD RIVER, S. C.—The Southern Power Company, capitalized at $7,000,000, of which Dr. W. G. Wylie, of New York, is president, and J. B. Duke, of New York, is vice-president, has purchased the water power at Ninety Islands on the Broad river in South Carolina. The development, which is to be begun at once, will give 12,000 horse-power, and will require an expenditure of $1,000,000. Power will be supplied to many cotton mills in and about Gaffney, Blacksburg and milling centres of upper South Carolina. The Southern Power Company now holds the absolute control of seven sites on the Catawba river, with a total possible development of 2,000,000 horse-power.

MAHONING & SHENANGO RAILWAY AND LIGHT COMPANY—Arrangements have been completed for the transfer of the stock of the Youngstown and Mahoning Valley street car lines for the stock of the Mahoning & Shenango Railway and Light Company, the new $10,000,000 corporation which comes into existence as a result of the merging of the two companies. The companies interested represent thirty-two trolley, electric light and gas companies. About $3,000,000 will be spent next year in improvements to the various properties. Four million dollars worth of preferred stock and $6,000,000 common stock will be issued. Randall Montgomery, of Youngstown, Ohio, it is understood, will be made vice-president and general manager.

NEW COMPANY TO OPERATE POWER PLANTS IN PENNSYLVANIA—The Chemical Light, Heat and Power Company is the title of a new corporation formed under a New York charter, in which a number of prominent Pittsburg capitalists are interested, and which will build a $200,000 plant at Beaver Falls. The company has a capital of $500,000, which will be increased to $1,500,000 shortly. It is a holding company formed to acquire and consolidate under one management several electric light companies and power plants. The new corporation has taken over the Wooster Gas Light Company, whose plant at Wooster, Ohio, has a capacity of thirty-five tons of coal a day. It has also secured the plant of the McWatters By-Products and Gas Manufacturing Company at Beaver Falls. The company expects to begin work on the Beaver Falls plant early in the new year.

THE NEW YORK CENTRAL'S HOLDING COMPANY—The Mohawk Valley Company has filed a certificate of increase of capital from $100,000 to $10,000,000. The capital is divided into 100,000 shares. The certificate is signed by Horace E. Andrews. Edward L. Rossiter, treasurer of the company, certifies that Mr. Andrews owns all of the capital stock. The instrument was executed in New York city. The company was incorporated February 6, 1905, to build, construct and equip railroads. One of the provisions of the certificate of incorporation reads: "The directors need not be stockholders of the corporation." The directors names in the certificate are William A. Greer, Frederick H. Meeder and C. W. Hutchinson, New York city; Milton S. Barger, Newport, R. I.; Charles H. Chambers, White Plains, N. Y.; William S. Langford, Yonkers, N. Y.; L. H. King, Dobb's Ferry, N. Y. The Mohawk Valley Company is the holding company which the New York Central has formed to take over its trolley lines and lighting plants.

INTERBOROUGH RAPID TRANSIT COMPANY ASSUMES CONTROL OF THE METROPOLITAN STREET RAILWAY COMPANY IN NEW YORK CITY—It is announced that Mr. August Belmont has purchased all the bonds and stock of the Metropolitan Street Railway and Metropolitan Securities Company, held by Mr. Thomas F. Ryan. This, it is understood, carries control of the Metropolitan companies. The passing of the control of these companies gives the Belmont interests complete control of the transportation systems of the boroughs of Manhattan and The Bronx. The Metropolitan Securities Company was incorporated under the laws of the state of New York, with a capital of $30,000,000, for the purpose of providing for the future needs of the Metropolitan Street Railway Company. It owns the entire capital stock of the New York City Railway Company, which, in turn, leases the Metropolitan Street Railway Company. It also owns all the stock of the People's Traction Company and the New York, Westchester & Connecticut Railway, and $3,379,000 of the stock of the Third Avenue Railway Company. The stockholders of the Metropolitan Street Railway Company were given the right to subscribe for $28,400,000 of the $30,000,000 of Metropolitan Securities stock, the remainder going to new interests. It is understood that the Metropolitan Securities Company will be made the holding company for the Interborough Rapid Transit Company and the Metropolitan Street Railway Company.

EDUCATIONAL.

TECHNICAL AND SCIENCE COURSES AT THE DETROIT (MICH.) YOUNG MEN'S CHRISTIAN ASSOCIATION—The Young Men's Christian Association, Detroit, Mich., announces technical and science courses in both the day and evening schools, taking up mechanical drawing, architectural drawing, free-hand drawing, sign lighting and lettering, steam engine and gas engine practice, electricity, chemistry, plumbing and electrical wiring. The course in electrical wiring is composed of the following subjects: arithmetic, plan reading and electricity, illustrated with dynamo and motor practice. The instructor in the electrical course is James B. McCarthy.

ENGINEERING SOCIETY.

NEW YORK CITY ALUMNI OF PURDUE UNIVERSITY—On the evening of Monday, December 18, about forty alumni of Purdue University, Lafayette, Ind., living in and about New York city, met and perfected the organization of the Purdue Alumni Association of the City of New York. P. E. Fansler, of J. G. White & Company, was elected president, and L. M. Grant, of the C. W. Hunt Company, was elected secretary-treasurer. The association will meet on the second Wednesday of every month. The list of charter members numbers about 100.

OBITUARY NOTICE.

MR. HENRY C. BUTT died at his home in Brooklyn, N. Y., on Sunday, December 17. For about forty years Mr. Butt was connected with the Western Union Telegraph Company in the New York Cotton Exchange. Mr. Butt was born in Brooklyn, and he had for some time been prominent socially and among various fraternal organizations.

TELEPHONE AND TELEGRAPH.

COOPERSTOWN, N. Y.—The Independent has placed in operation a line between Cooperstown and Oneonta.

NEWARK, N. J.—A new central office of the New York & New Jersey Telephone Company has been opened.

UTICA, N. Y.—A new telephone line is soon to be opened from Grant and Northwood by way of Ninety-six to Remsen.

GAINESVILLE, ALA.—It is stated that the Bell Telephone Company will rebuild and improve its line from Epes to Gainesville.

WHEELING, W. VA.—The National Telephone Company is running ten wires from Wheeling to Claysville, Pa.

EUGENE, ORE.—The Pacific States Telephone and Telegraph Company's new system in Eugene has been completed.

SOMERSET, PA.—The Bell Telephone Company has been making extensive improvements to its lines in Somerset county.

NEWTON, MISS.—The Cumberland Telephone Company will install a new switchboard at Newton, and will also make other improvements.

DIXFIELD, ME.—The Northeastern Telephone Company has completed a new line from Wilton and Farmington, connecting with Portland.

SANTA FE, N. M.—The telegraph line from Santa Fe to Torrance and the telephone line from Santa Fe to Cerrillos have been bought from H. T. Gibson by J. W. Mayers.

MILWAUKEE, WIS.—Telephone connection between Appleton and Green Bay, on the lines of the Fox River Valley Telephone and Telegraph Company, has been completed.

AUSTIN, TEX.—The Texas Consolidated Long-Distance Telephone Company, of Dallas, has filed an amendment to its charter, increasing its capital stock from $120,000 to $240,000.

PLAINFIELD, N. J.—During the early part of next year the New York & New Jersey Telephone Company will start the work of changing the telephones in Plainfield to the common battery system.

SAN DIEGO, CAL.—The subscribers of the Home Telephone Company in San Diego will be connected up with the exchange in Los Angeles by means of the new through circuit which has just been put in.

ALLENTOWN, PA.—The recently incorporated Franklin Telephone and Telegraph Company has about completed the construction of a telephone line from Quakertown to Riegelsville, with Springtown as its centre.

CROSBY CREEK, N. Y.—At a meeting of the Crosby Creek Telephone Company the following officers were elected: W. J. Price, president; Joseph Knapp, vice-president; F. M. Olin, secretary; Fred Olin, treasurer.

OAKLAND, CAL.—The Home Telephone Company, of Alameda county, was the successful bidder for a fifty-year franchise to operate and maintain a telephone system in Oakland. The price paid for the privilege was $35,431.30.

RIVERHEAD, N. Y.—The lines of the North Shore Telephone Company and the Baiting Hollow & Roanoke Telephone Company have been connected at Wading River and the local service thus extended to Port Jefferson and to Patchogue.

ALBANY, N. Y.—The net number of subscribers added by the Hudson River Telephone Company during November was 1,030, which brings the total number of stations in the territory up to 38,000, and is a gain, for eleven months, of 8,300.

FLUSHING, N. Y.—The plans and specifications for the new building, which the New York & New Jersey Telephone Company intends to erect, have been completed, and the contract for the construction of the building has been awarded.

BAY CITY, MICH.—The Bell Telephone Company's new work at Frankenmuth is progressing rapidly. About sixty miles of territory are being covered, including Frankenmuth village and vicinity, giving service to from 150 to 200 subscribers.

PULASKI, TENN.—Having withdrawn its application for a franchise in the town of Pulaski, it is now announced that the Long-Distance Telephone Company will buy property on East Hill, outside the corporate limits, and establish an exchange there.

TROY, N. Y.—The Granville Telephone Company has purchased the New England Telephone and Telegraph Company's line at Castleton, Fair Haven, West Haven and Poultney, and that of the Hudson River Telephone Company at Ticonderoga, Whitehall, Granville, Salem and Cambridge.

BOISE, IDA.—The Rocky Mountain Bell Telephone Company has awarded a contract for the construction of a twenty-five by sixty-one-foot addition to its present building. The contract calls for the completion of the work of excavation and the erection of the walls, roof and floors by February 1.

PITTSBURG, PA.—The Central District and Printing Telegraph Company has completed the construction of a telephone cable between McKeesport and Sewickley, which will give direct connection with all of the underground telephone wires between these points and open up a service entirely underground that involves 300 miles.

MONTPELIER, VT.—The New England Telephone Company has begun to entirely rebuild its main line between Burlington and Montpelier. Beginning at South Burlington a new pole line will be erected to Richmond *via* Williston, shortening the distance fully two miles. Operations will not be begun upon erecting the new office building in Burlington until early spring.

DECATUR, ALA.—The Inter-County Telephone Company, a new independent telephone company, has completed its system. This company will cover the eastern part of the county, which has never had telephone service, and will connect with Huntsville. The capital stock is $20,000, and the officers are: president, C. E. Hodgeboom; vice-president, Gus May; secretary, C. D. Hodgeboom.

NEW ORLEANS, LA.—G. H. Groce, superintendent of the telegraph system of the Illinois Central, announces that his line will immediately begin the construction of a telephone system, which is to extend from New Orleans to Louisville, and from Fulton, Ky., to Chicago. The contract has already been let for this work to the Bell company and work will commence at once.

WASHINGTON, D. C.—As result of negotiations between Electrical Engineer Walter C. Allen, on behalf of the District, and F. H. Bethel, general manager of the Chespeake & Potomac Telephone Company, the commissioners have received a proposal from the company for changing the present magneto system of the District switchboard to a common battery system and for furnishing the necessary equipment.

MOBILE, ALA.—The Home Telephone Company has begun the work of putting 300,000 feet of wires under ground. It is estimated that fully $350,000 will be expended by the company on its local plant, as well as its long-distance connections between Mobile and Baldwin counties. In addition, the company is building a modern exchange on Conception street. Switchboards are to be put in, making provision for 2,000 subscribers.

ALBANY, N. Y.—A deal has been consummated by the Independent Union Telephone Company, of Albany, whereby it secures possession of the Independent Telephone Company, of Herkimer county, which operates a rural line out of the village of Herkimer. The system transferred to the Albany company is located in the towns of Herkimer, German Flatts and Little Falls, and is connected with the Herkimer telephone system. The line extends from that village to the south side of the Mohawk river, thence to Fort Herkimer and Jacksonburg, and also includes the line extending to Small's Bush and Snell's Bush.

DANBURY, CT.—The American Telephone and Telegraph Company has begun operations in South Norwalk upon the construction of a telephone and telegraph line from that city to Pittsfield, Mass. The line will pass through Danbury. It will be 113 miles in length and as far as the Massachusetts state line will have a capacity of sixty wires. From that point to Pittsfield the poles will have a capacity of forty wires. The line is being constructed in connection with the underground system from New York to New Haven. A force of men is at work in South Norwalk and will extend its operations toward Danbury as rapidly as possible. The line will come in through the vicinity of Mountainville and will go across the southern part of the city. Connections will be made with the local office of the Southern New England Telephone Company.

ELECTRIC LIGHTING.

BOISE, IDA.—The Capital Electric Company has connected with North Locust Grove and Ireland.

DECATUR, ILL.—The city council has decided to spend $5,000 for new electric lighting machinery.

SWEETWATER, TENN.—A stock company is being organized to install an electric light plant at Madisonville.

DERRY, N. H.—A new 133-horse-power generator has been installed at the power station of the Derry Electric Light Company.

MANCHESTER, CT.—Maro C. Chapman, who is secretary and treasurer of the Manchester Light and Power Company, has acquired the large holdings of N. T. Pulsifer in that company.

SALT LAKE CITY, UTAH—The Payson city electric light plant is now completed. It is equipped with a 125-horse-power engine, with two eighty-horse-power boilers and a 100-kilowatt dynamo.

MOUNT HOLLY, PA.—At the regular meeting of the Mount Holly town council the bid for lighting the town from the company formed to utilize the water power at Boiling Springs was accepted.

PLAQUEMINE, LA.—The electric light plant, which has been in the course of construction here some months, has been completed. The Plaquemine Electric Light and Power Company has the franchise.

WAMEGO, KAN.—The city of Wamego has installed an electric light plant. There are nineteen street arc lights and eighteen street incandescents. The city starts with customers for 1,200 incandescent lights.

NOBLESVILLE, IND.—Capitalists of Peru have obtained a franchise for an electric light plant at Arcadia, and the same plant will be utilized in providing electric light for the streets of Atlanta, three miles distant.

MECHANICSBURG, PA.—Mechanicsburg has entered into a ten-year contract with the United Electric Campany for an all-night service at $60 for each 1,600-candle-power arc light and $16 for each thirty two-candle-power light.

ALBANY, N. Y.—The state lighting commission has granted the application of the Palmyra Gas and Electric Company for consent to issue bonds to the amount of $40,000 to the Ithaca Trust Company, of Ithaca, N. Y., as trustee.

SANTA CRUZ, CAL.—The Santa Cruz Electric Light and Power Company, which furnishes lights, both electric and gas, to Santa Cruz, has been sold to John Martin and E. P. Lowe, of San Francisco, representing the Bay Counties Power Company.

OTTAWA, ONT.—The minister of public works has been asked to grant a privilege on the Niagara river. The applicant is the Canadian Niagara Power Company, which desires to suspend a wire from Fort Erie on the Ontario side to Buffalo, N. Y. The company has also applied to the war department at Washington, which has power on the American side over waterways similar to that of the public works department in Canada.

PATERSON, N. J.—The board of aldermen, with one member dissenting, killed the proposed city lighting franchises of the Paterson Electric Light, Heat and Power Company, which offered $3,000 a year to the municipality and a reduction of fifteen per cent from present prices. The aldermen had already passed a resolution to prepare a bill allowing Paterson to construct its own lighting plant.

ST. PAUL, MINN.—The council, at an adjourned meeting, awarded the 1906 incandescent street-lighting contract to the present contractors, the Patterson Street Lighting Company, of St. Paul and Minneapolis. The price per lamp is to be $12.25, a reduction of $1.15 under the contract of this year and fifty-nine cents under the previous bid of the company submitted in answer to the first advertisement.

MUSKEGON, MICH.—At a meeting of the common council the amendment asked for by the Muskegon Traction and Lighting Company was unanimously passed with the concessions granted, which were demanded by the citizens' committee and several aldermen. These concessions mean to the city a saving of $20,000 yearly, due to a twenty-two and one-half per cent reduction in the price of illuminating gas and a twenty per cent reduction in the price of electric current.

TERRE HAUTE, IND.—The remonstrance against the city installing an electric lighting plant has been presented to the board of public works by a committee of prominent citizens. The remonstrance was signed by 150 well-known names, each of the banks being represented and many large business enterprises. One of the grounds cited by the remonstrators was that there is no information as to the cost of the plant. Another objection was that there is doubt if the city's debt limit will permit the investment. The board says the city now has a margin of more than enough, and that after January 1 the margin will be $200,000. The opponents say the cost of the plant will be $200,000 or more. The city administration is to go ahead with the enterprise, despite the remonstrance.

LOCKPORT, N. Y.—It is stated that the Niagara, Lockport & Ontario Power Company has contracted to sell all of the electric power that it will be able to deliver over one transmission line, and will in the spring construct a second line of poles from the Niagara frontier to Rochester and possibly to Syracuse. At present two sets of towers extend along the private right of way of the company from Niagara Falls to Raymond hill, six miles south of Lockport in the town of Royalton. One set of towers continues from Raymond hill to Rochester, while the other branches off to the south and will meet the West Shore at Akron. The line will also extend to Batavia, where it is said the power company has large contracts.

ROCHESTER, N. Y.—The Eastern Monroe Electric Light and Gas Company is installing new machinery and developing its water power on Irondequoit creek, in preparation for fulfilling its contract to light the village of Brighton, now the Twenty-first ward, after January 1 next. This company's plant is several years old and has been worked to its capacity in meeting the demands of Despatch, Penfield and business concerns. On November 25, 1904, the village trustees of Brighton granted a franchise to William H. Rowerdink for electric or gas lighting throughout the village, with privileges for crossing the streets, laying pipes or conduits. The franchise was granted to Mr. Rowerdink in the name of the Suburban Gas and Electric Company, but he assigned his interest to the Eastern Monroe Electric Light and Gas Company, practically the same organization as the first named, under a new title.

ELKTON, MD.—One of the most important industrial developments in Cecil county has been made by William T. Warburton, of Elkton, president of the Second National Bank. Early in the year he purchased the flour mills and water power known as Gilpin's falls, near Bayview. He thus secured control of the falls and in connection therewith the construction of a hydraulic electric plant is now about completed and will be ready for operation within a short time. Pole lines have been completed from the falls to Elkton, by way of Pleasant Hill, Leeds and Childs station, on the Baltimore & Ohio Railroad, and from the falls to North East by way of Leslie and Bayview. Elkton and North East will be lighted by power from the falls. A substation has been erected in Elkton. The lines will be extended and all the principal towns in Cecil county furnished with light and power. The head is 130 feet; a steel flume, forty-two inches in diameter and 1,120 feet in length, conveys the water from the dam and delivers it to the wheels. The flume is supported by abutments of heavy masonry located sixteen feet apart.

SYRACUSE, N. Y.—The Niagara, Lockport & Ontario Power Company has started the construction of its transmission line in Onondaga county. Towers to carry the cables have been erected on either side of Jordan and the work is extending toward Syracuse and Rochester. At another point west towers have also been erected. The construction toward Syracuse has gone along as far as Warner. Civil engineers in the employ of the company are surveying a strip of land about two hundred feet wide, from the Monroe county line through Wayne county to the Cayuga county line, upon which it will erect its towers which will support the cables conveying electricity from Niagara Falls to Syracuse. This power line will not, as has been stated, follow the line of the West Shore Railroad and on its property, but will run upon private property very largely, because of the sharp curves in the railroad. For this reason the attorneys of the Niagara, Lockport & Ontario Power Company have been securing franchises from town boards, enabling the company to cross each and every lane, alley, road and highway in the respective towns.

ELECTRIC RAILWAYS.

ORISKANY FALLS, N. Y.—The board of trustees of Oriskany Falls has granted a franchise to T. F. McBride as trustee for the promoters of the Oriskany Valley Electric Railway Company.

UTICA, N. Y.—The first section of the West Shore Railroad to be used by trolley cars has been opened for business. The line has been electrified for a distance of about three miles between Utica and Little Falls.

YORK, PA.—The Lewisberry & Strinestown Electric Railway Company has filed papers for an extension of its lines from Strinestown to York, a distance of about eighteen miles. Two entrances into York are proposed.

MADISON, N. Y.—A franchise to construct a street railway on certain portions of the highways of Madison was granted at a meeting of the residents of the village. The application was made by Thomas F. McBride as trustee for the promoters.

ANACORTES, WASH.—The preliminary survey has been completed and the proposed electric railway line from Marblemount, on the upper Skagit river, to the Doubtful lake group of mines, a distance of twenty-five miles, will be pushed to completion.

NORFOLK, VA.—The property of the Hampton Roads Railway and Electric Company, of Newport News, Va., which was recently sold under foreclosure and transferred to the Hampton Roads Traction Company, has been in turn transferred to the Newport News & Old Point Railway Company.

BLUFFTON, IND.—Capitalists interested in the Marion, Bluffton & Eastern interurban are having surveyed a line between Bluffton, Ind., and Celina, Ohio, through Vera Cruz, Linn Grove and Geneva, and will also run a line from Bluffton to Van Wert, Ohio, *via* Decatur, Ind., and Ohio City, Ohio.

MARION, IND.—The deal of the Indiana Union Traction Company to purchase the Indiana Northern Traction Company's line from Marion to Wabash has been closed. By the purchase the Indiana Union Traction Company adds eighteen miles of track to its system. It has been operating 270 miles.

POTTSVILLE, PA.—A syndicate of Schuylkill county capitalists is being formed to build a trolley line between Pottsville, Minersville, Lytle, Forestville and intervening points, to connect with the traction lines into Scranton. The road will furnish through trolley connections between Philadelphia and Mauch Chunk.

BURLINGTON, VT.—Capitalists interested in electric railways will petition the Vermont legislature for a charter for the Champlain Valley Electric Road Company. The route is through Burlington, Shelburne, Charlotte, Ferrisburg, Vergennes, Panton, Addison, Bridgeport, Shoreham and Orwell, with an ultimate outlet at Rutland.

PERU, IND.—The Winona Traction Company has abandoned the route from Warsaw to Akron *via* Mentone for its line between Peru and Warsaw. The line will be built paralleling the Big Four railroad from Warsaw to Silver Lake and thence to Akron. The company expects to have the line built between Peru and Warsaw by the first of next July.

RICHMOND, VA.—Phillips & Alport and H. H. George, Jr., have been awarded the contracts for grading and preparation for track-laying of the Richmond-Ashland division of the Richmond & Chesapeake Bay Railway. The work is to start as soon as the two firms can get their camps on the ground. The contracts call for the completion of the road by early summer.

BOSTON, MASS.—At the annual meeting of the Boston & Worcester Electric Companies President Shaw reported that for the year ended September 20 the earnings show an increase of $53,882, or over thirteen per cent. The property has earned four per cent on the preferred shares outstanding, after allowing liberal charges for the taking care of its track, roadway and equipment.

LATROBE, PA.—The franchises, property, interests and good will of the Latrobe Street Railway Company and its subsidiary, the Latrobe Electric Light Company, have been taken over by the West Penn Railway Company, the Latrobe stockholders retiring from all active interest in the property. The Latrobe officers—John B. Anderson, president, and Joseph C. Head, secretary—have retired.

MOUNT STERLING, KY.—The Montgomery County Fiscal Court has granted a franchise to Younger Alexander, of Lexington, for a new electric interurban line twenty miles in length to cost $500,000, from Paris to North Middletown and Mount Sterling. Associated in the enterprise are J. M. Bigstaff and M. O. Cockrell, Mount Sterling; Henry A. Power, Paris; John T. Collins and W. A. Thomason, of North Middletown.

ROCHESTER, N. Y.—It is probable that work on the proposed Rochester, Scottsville & Caledonia trolley road will be begun next spring, or as soon thereafter as the necessary consent can be obtained from the state railroad commission. Permission has been given the company by the town of Brighton to construct, maintain and operate a trolley railroad over and across certain streets in that town. It was the last of the town and village franchises to be secured.

KOKOMO, IND.—It is believed that the Kokomo, Marion & Western traction line will be extended next year from Kokomo to Burlington, fifteen miles west. The officials of the traction company have received from Burlington an offer to pledge payment of a subsidy of $40,000 for the proposed extension. Many farmers in the western part of Howard county and the eastern part of Carroll county already have indicated their willingness to give land for a right of way.

CHARLEROI, PA.—S. L. Tone, vice-president of the Pittsburg Railways Company, has completed paying for the rights of way on which the Pittsburg & Charleroi street railway line will be extended to Roscoe. The Pittsburg Railways Company has bought the entire stock, rights of way and other property of the Allenport & Roscoe Street Railway Company. An aggregate price of $25,000 was paid out to farmers in the Allenport region. It is expected that cars will run from Pittsburg to Roscoe next spring.

INDIANAPOLIS, IND.—The Indianapolis & Frankfort Traction Company has been organized to build an interurban line from Carmel to Frankfort *via* Westfield, Hortonville, Sheridan, Terhune, Kirklin and Cyclone, and from Sheridan to Frankfort *via* Kempton, Tipton county. The directors of the company are Frank E. Gavin, Theodore P. Davis and Albert C. Pearson. Members of the company announced that they will begin the work of obtaining rights of way at once and will start actual work on the two lines in the spring.

WAREHOUSE POINT, CT.—The street railway line which the Rockville, Broad Brook & East Windsor Street Railway Company is constructing from Warehouse Point to Rockville has been completed to Broad Brook, and the section has been opened to public travel. The remainder of the road is now approaching completion and the entire line will be in operation before the end of the year. The road is controlled by the Hartford & Springfield Street Railway Company, and power is furnished from the latter company's plant at Warehouse Point.

NEW HAVEN, CT.—An official statement of the Connecticut Railway and Lighting Company, which owns about 175 miles of trolley tracks in the state and has many constituent companies, shows gross earnings during the last ten months of $1,882,366 as compared with earnings last year of $1,683,776 during the corresponding time, a gain for the ten months this year of $198,590. Of the gross earnings this year $1,294,979 came from the trolleys, $328,977 from the electric light and power companies, and $258,410 from the gas companies owned by the corporation.

CANON CITY, COL.—Negotiations between the Canon City Merchants' Association and Frank S. Granger, of San Jose, Cal., for an electric railway system connecting Canon City with Florence, seven miles distant, as well as its immediate suburbs, have resulted in the signing of a contract between an executive committee of seven citizens on the part of the city and Mr. Granger, in which it is agreed to pay Mr. Granger a bonus of $25,000 for the installation of between sixteen and seventeen miles of road. Mr. Granger expects to begin work as soon as the necessary franchises can be obtained and other preliminaries settled.

BROOKLYN, N. Y.—The Belmont syndicate and the Long Island Railroad Company have jointly become owners of the trolley line

which runs from Queens, L. I., through Jamaica to Far Rockaway. The property was purchased to extend the street electric system in Queens and Nassau counties controlled by the two interests. The purchase has about fifteen miles of track and is said to be a profitable line. It owns valuable franchises besides its own power-house and electrical equipment. The Belmont syndicate and the Long Island Railroad have a franchise for a trolley line on the Jericho turnpike, and it is reported that they are getting ready to build the road. They own all the trolley lines in Nassau county.

BETHLEHEM, PA.—At a general meeting of the stockholders of the several companies interested, it was decided to merge the following trolley roads into one company: Bethlehem & Bath Street Railway Company, Nazareth & Bath Street Railway Company, Bethlehem & Siegfried Street Railway Company, Cement Belt Street Railway Company, Alliance, Bath & Nazareth Street Railway Company, Alliance & Bath Street Railway, Township Line Street Railway Company, Allen Street Railway Company. The main office of the new concern will be located in Bethlehem. The lines concerned in the deal belong to Howard Mutchler, of Easton, and J. S. Moyer, of Bethlehem.

PERSONAL MENTION.

MR. ALFRED M. BETTY, of Knoxville, Tenn., who has been manager for the Postal Telegraph-Cable Company at Knoxville, has been appointed manager of the Postal company's Atlanta (Ga.) office, to succeed J. E. Schofield, resigned.

MR. J. A. TRAWICK has resigned after five and one-half years of service as general manager of the Little Rock (Ark.) Railway and Electric Company. Mr. Trawick is succeeded by Mr. O. C. Simpson, who comes from Birmingham, Ala.

PRESIDENT F. P. FISH, of the American Telephone and Telegraph Company, will make a trip to the Pacific coast for the inspection of telephone companies in the West. It is expected that Mr. Fish will be absent about three weeks.

MR. A. W. LEONARD, the retiring general manager of the Houghton County (Mich.) Electric Light Company and the Houghton County Street Railway Company, was presented before his departure with a gold watch and chain by the employés of the two companies. Mr. Leonard is to take a position as general manager of the Minneapolis (Minn.) Electric Light Company, succeeding Mr. A. M. Robertson.

PROFESSOR N. MONROE HOPKINS has been appointed chief electrical engineer of the Bureau of Docks and Yards, Navy Department, Washington, D. C. The office is a new one which has become necessary by reason of the extending use of electricity in the navy yards and stations. Professor Hopkins is a graduate of the George Washington University, where for several years he has held the chair of electrochemistry.

MR. GASTON HARBISON, Buffalo, N. Y., has initiated a striking method of directing the attention of business managers to the work which he is prepared to do. Mr. Harbison is an advertising manager of undoubted ability. In a circular, which he is giving rather broadcast distribution, he makes a bold statement concerning the qualities which he offers, and makes a bid for an opportunity on a high-grade basis.

MR. HENRY C. EBERT, who for fifteen years was associated with the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., was the guest of honor at a banquet at the Hotel Schenley, Pittsburg, on the evening of December 17. Mr. Ebert goes to Cincinnati, Ohio, to become president of the Cincinnati Car Company. Mr. Walter M. McFarland acted as toastmaster, and during the evening Mr. Ebert was presented with a bronze lamp.

NEW MANUFACTURING AND CONSTRUCTING COMPANIES.

DES MOINES, IOWA—The National Electric Manufacturing Company has been incorporated by L. E. Heifner and others, with a capital of $10,000.

ALBANY, N. Y.—The Telegraph Signal Company, of Rochester, has filed a certificate of incorporation with the secretary of state. The capital is to be $1,000,000, in ten thousand shares, half preferred and half common stock. The directors are James G. Halleran and John McGarvey, of Rochester; Menzo J. Stover and Henry Billings, of Morton, and Othello A. Huff, of Kent, N. Y.

ELECTRICAL SECURITIES.

The rather extensive bank failure in Chicago in the early part of last week, the continued high standard of money of every description, and the natural conservatism of many banking institutions, have been unable to check the bull campaign, which has now been having things its own way for several weeks in the stock market. The new disturbing Russian developments, with increased violence during the strikes and riots, acted as a temporary check because of the foreign uncertainty, but even the extraordinary casualties in this direction have not abated the feeling of buoyancy which is evidenced in every financial centre in this country. It is expected that the first of the year settlements will be the largest on record, involving a further strain on money resources. The Interborough-Metropolitan traction deal is expected to bring about the usual bracing effect upon the other traction interests. Many people now look for the Belmont interests to absorb the Brooklyn Rapid Transit properties, forming a practical transportation monopoly.

ELECTRICAL SECURITIES FOR THE WEEK ENDING DECEMBER 23.

New York:	*Closing.*
Brooklyn Rapid Transit	89⅛
Consolidated Gas	179
General Electric	176½
Interborough Rapid Transit	236½
Kings County Electric	200
Manhattan Elevated	163
Metropolitan Street Railway	127⅝
New York & New Jersey Telephone	156
Westinghouse Manufacturing Company	190

The regular quarterly dividend of 1¾ per cent will be paid on Metropolitan Street Railway Stock January 15. Books closed December 26 and will reopen January 16.

Directors of the Westinghouse Electric and Manufacturing Company have declared the regular quarterly dividend of 2½ per cent on the preferred, assenting and non-assenting stocks. Books will remain closed from December 26 to January 11.

Boston:	*Closing.*
American Telephone and Telegraph	138¼
Edison Electric Illuminating	240
Massachusetts Electric	58
New England Telephone	131½
Western Telephone and Telegraph preferred	91

At the annual meeting of the Massachusetts Electric Companies, Richard Olney, Charles E. Cotting, Eugene N. Foss, Percy Parker and Charles Francis Adams, 2d, were reelected trustees for the three years next ensuing.

Directors of the American Telephone and Telegraph Company have declared the regular quarterly dividend of 1½ per cent and an extra dividend of ¾ per cent. This is the usual rate that is declared in June and December, while 1½ per cent is usually declared in March and September. Coupons from the 4 per cent collateral trust bonds of the company, by their terms payable on January 1, 1906, at the office of the treasurer in New York, will be paid by the Manhattan Trust Company, 20 Wall street. The instrument statement for the month of November is as follows: gross output, 183,470; returned, 49,075; net output, 134,395, as compared with 63,988 for November, 1904. Since December 31, 1904, the net output has been 1,111,242, and the total now outstanding is 5,591,811.

Philadelphia:	*Closing.*
Electric Company of America	11
Electric Storage Battery common	80½
Electric Storage Battery preferred	80½
Philadelphia Electric	8⅜
Philadelphia Rapid Transit	30½
United Gas Improvement	94½

The directors of the Electric Storage Battery Company have declared the regular quarterly dividends of 1¼ per cent on the preferred and common stocks.

Chicago:	*Closing.*
Chicago Telephone	138
Chicago Edison Light	160
Metropolitan Elevated preferred	69½
National Carbon common	80¼
National Carbon preferred	115¼
Union Traction common	12⅜
Union Traction preferred	40

The directors of the National Carbon Company have declared a semi-annual dividend of 2 per cent on the common stock, payable January 15. Books close January 5 and reopen January 16. This is an increase of one-half of 1 per cent. The June dividend having been 1½ per cent.

INDUSTRIAL ITEMS.

THE STANDARD ROLLER BEARING COMPANY, Philadelphia, Pa., has started the erection of a brass and iron foundry sixty feet by 125 feet, two stories high. The company's crucible steel-casting plant was started up last week, this being a building sixty feet by ninety-five feet.

THE CLARY-JEMISON COMPANY, First National Bank Building, Birmingham, Ala., manufacturers' agent, is among the first to issue calendars for 1906 with a beautiful lithograph mounted upon a large cream mat. The subject is by A. Asti, and the work is more than ordinarily good.

THE DEVEAU TELEPHONE MANUFACTURING COMPANY, New York city, will be pleased to send a copy of the "DeVeau Diamond," which is published occasionally by this company. This little publication contains a number of short sketches relative to the advantages of the DeVeau telephone apparatus.

THE FARR TELEPHONE AND CONSTRUCTION SUPPLY COMPANY, 118 and 120 West Jackson Boulevard, Chicago, Ill., has ready for distribution catalogue No. 18 for 1906. The company carries a large stock of telephones, line supplies, linemen's tools, batteries and battery supplies, and is prepared to fill orders promptly.

THE ABNER DOBLE COMPANY, San Francisco, Cal., has issued bulletin No. 7, 1906, descriptive and illustrative of Doble tangential water wheels, Doble patented needle-regulating nozzles, Doble patented ellipsoidal buckets, Doble patented high-speed, ring-oiling bearings. The text is very illuminating and complete, and the book is well illustrated.

F. M. HICKS & COMPANY, Fisher Building, Chicago, Ill., is distributing a paper-weight in the shape of a miniature locomotive to its customers and friends. In our issue of December 9 this matter was referred to. The souvenir, however, is not for general distribution, but is exclusively for the company's clients among the railroad men.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has issued bulletin No. 1046, describing Bullock multipolar motors and generators. The book is handsomely printed, and in addition to a number of views of typical installations and adaptations, a detailed description of these machines is given, supplemented by views of the various parts.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has prepared a series of new bulletins which are to be inserted in the perpetual catalogue, taking the place of others which have become obsolete through changes of some sort or other. These bulletins give the dimensions and illustrations of the apparatus, together with a brief description.

STANLEY & PATTERSON, INCORPORATED, 40 Cortlandt street, New York city, is distributing a large mailing card which is made up of a combination of the illustrations which have been used in its advertising for the past several months. On the reverse side there is a brief argument detailing the principal features of construction of the "Faraday" skeleton bell.

THE DIEHL MANUFACTURING COMPANY, Elizabethport, N. J., has recently completed an installation of a plant in a veneer mill at Cairo, Ill., consisting of two 250-kilowatt generators, engine type, 250 volts, 150 revolutions per minute; one 200-horse-power, three 125-horse-power, one seventy-five-horse-power, one thirty-horse-power and one fifteen-horse-power motors.

THE WESCO SUPPLY COMPANY, St. Louis, Mo., announces that it has made arrangements for the southwestern agency for one of the largest and oldest manufacturers of telephone cable, and is prepared to quote prices on any quantity of cable to meet any desired specifications. The company is also prepared to make immediate deliveries from large stock which it will carry in St. Louis.

THE WIRE AND TELEPHONE COMPANY OF AMERICA, Rome, N. Y., announces that at a meeting of the board of directors on December 8, 1905, the following changes were made: J. S. Dyett, of Rome, N. Y., was elected president, to succeed C. F. M. Niles, of Toledo, Ohio; Oliver Shiras, of Rome, N. Y., was elected vice-president, to succeed Mr. Dyett; and S. H. Pell, of the firm of Pell & Company, New York city, was elected a director.

THE NORTHERN ELECTRICAL MANUFACTURING COMPANY, Madison, Wis., will be pleased to send bulletin No. 32, descriptive of equipment for crane and hoisting work. The box-type motor, which the Northern company has developed, is particularly adaptable for this class of service. The motors are built with heavy armature shafts and liberal bearings. They may be made enclosed and dustproof, and are adapted for situations where they will have to withstand exposure.

THE ELECTRICAL TESTING LABORATORIES, Eightieth street and East End avenue, New York city, announces that Mr. E. M. Farmer is now at the Westinghouse works at East Pittsburg, Pa., conducting acceptance tests on a large order of electrical apparatus, including two 1,500-kilowatt generators, nine 1,000-kilowatt transformers and rotary converters, smaller transformers, etc., for the Grand Rapids-Muskegon Water-Power Electric Company, of Grand Rapids, Mich.

THE CHICAGO PNEUMATIC TOOL COMPANY, Chicago, Ill., announces that it has been awarded the gold medal at the Liege Exposition, covering pneumatic tools and appliances; and the silver medal for the "Franklin" air-compressors. The gold medal was the highest award for pneumatic tools and appliances. The company regards this as a further evidence of the completeness of its line, and announces that it has always received the highest honors since its first exhibit was made at the Cotton States Exposition at Atlanta, Ga., 1895.

THE NATIONAL CARBON COMPANY, Cleveland, Ohio, announces that it brought suit before Judge Kohlsaat in Chicago, Ill., with the result that on December 12 an injunction was issued against the Columbia Dry Battery Company and the Vim Company, both of Chicago, forbidding them from offering for sale any dry batteries not made by the National Carbon Company, to which is applied the word "Columbia" or the words "Columbia Dry Battery Company." The effect of this injunction is to confirm the National Carbon Company in the possession of the trade-mark "Columbia."

THE CHICAGO PNEUMATIC TOOL COMPANY, Fisher Building, Chicago, Ill., has ready for distribution its catalogue No. 17. This catalogue covers the entire line of pneumatic tools and appliances, together with a complete price list of repair parts entering into all the tools in general use, including the "Boyer" and "Keller" products. This handsome catalogue, containing 192 pages, six inches by nine inches, very clearly illustrates the growth of the pneumatic tool business of this company, when a comparison is made with the first advertising literature which it issued eleven years ago. This consisted of a small sixteen-page folder for enclosing in the regular six-by-three and one-quarter-inch envelope.

M. W. DUNTON & COMPANY, 65 Atlantic avenue, Providence, R. I., is offering a "Little Beauty" pocket blow-torch as a premium for the return of fifty covers from its two-ounce decorated boxes of "Nokorode." "Nokorode" is a soldering paste which has been produced particularly for the electrical trade in general. Great care has been exercised to make it a non-corrosive soldering flux, which can be used safely on the most delicate electrical instruments and connections. The company states that it has a number of incandescent lamp manufacturers, telephone builders and makers of other electrical appliances who are using it exclusively. The company reports that it has experienced a very gratifying increase in its business during the past year. The blow-torch is thoroughly nickel-plated, six inches high and two and seven-eighths inches around. There is a screw-cap, so that the alcohol can not evaporate. The apparatus is thoroughly practicable, and is well worth an effort to secure.

EXPORT AND DOMESTIC NUMBER

ELECTRICAL REVIEW

VOL. XLVII—No. 2. NEW YORK, SATURDAY, JULY 8, 1905. TEN CENTS A COPY
THREE DOLLARS A YEAR.
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THE PHOENIX GLASS CO.
PITTSBURG NEW YORK CHICAGO
Manufacturers of
Electric Globes and Shades, both Arc and Incandescent
Inner and Outer Globes for all enclosed arc systems
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GEO. T. MANSON, GEN. SUPT.
W. H. HODGINS, SECY.
1889 PARIS EXPOSITION MEDAL FOR RUBBER INSULATION
OKONITE
TRADE MARK
1893 WORLD'S FAIR MEDAL FOR RUBBER INSULATION
THE STANDARD FOR RUBBER INSULATION
Sole Manufacturers of OKONITE WIRES, OKONITE TAPE, MANSON TAPE, CANDEE WEATHERPROOF WIRES. Write for Prices
THE OKONITE CO., Ltd., 253 Broadway, New York

AMERICA'S LARGEST ELECTRICAL SUPPLY HOUSE
ELECTRIC APPLIANCE COMPANY CHICAGO
134-140 W. JACKSON BLVD.
ELECTRICAL SUPPLIES. SPECIALISTS ON METERS, TRANSFORMERS, LAMPS, ETC.

GONDA
TRADE MARK
THE STANDARD OPEN CIRCUIT BATTERIES OF THE WORLD
THE LECLANCHE BATTERY CO.
141-147 E. 131st ST. NEW YORK

HOMER OF CLEVELAND
COMMUTATORS-NOTHING ELSE
THE HOMER COMMUTATOR CO.
CLEVELAND, O., U. S. A.

Packard
(LICENSED)
Incandescent Lamps
New York & Ohio Company
402 North Ave., Warren, Ohio

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ESTABLISHED 1880
PHILADELPHIA

THE BRISTOL CO.
WATERBURY, CT.
Recording Voltmeters
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Recording Thermometers
PAY FOR THEMSELVES
SEND FOR CATALOGUE

The National Conduit and Cable Company
Executive Offices
41 Park Row, - NEW YORK, N. Y.
Manufacturers of
BARE COPPER WIRE AND CABLE
PAPER INSULATED CABLES
For Telephone, Telegraph, Electric Light and Power
FIRE AND WEATHERPROOF WIRE

"CIRCULAR LOOM"
AMERICAN CIRCULAR LOOM CO.
TRADE MARK REGISTERED
FOR INTERIOR WIRING
AMERICAN CIRCULAR LOOM CO.
CHELSEA, MASS.
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WIRES AND CABLES.
NATIONAL INDIA RUBBER CO.
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PARANITE
INDIANA RUBBER AND INSULATED WIRE CO.
MANUFACTURERS OF
PARANITE RUBBER COVERED WIRES AND CABLES
Underground, Aerial, Submarine and Inside Use
TELEPHONE, TELEGRAPH AND FIRE ALARM CABLES
All Wires Are Tested at Factory
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BARE and INSULATED ELECTRIC WIRE
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Largest Line of RAILWAY, TELEPHONE and LIGHTING SUPPLIES in New England
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Manufacturers all kinds of LICENSED
INCANDESCENT LAMPS.....
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For all purposes in any quantity
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RUBBER INSULATED
WIRES AND CABLES
Aerial Submarine Flameproof
Lead Covered Steel Taped
Prompt Attention to Special Requirements
THE SIMPLEX ELECTRICAL CO.
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THE ONLY SUCCESSFUL TURN-DOWN ELECTRIC LAMP
IT SAVES ⅓ OF YOUR LIGHT BILL.
WRITE FOR OUR CATALOGUE AND PRICE LIST.
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Bishop Wires and Cables
Meeting the most trying conditions a specialty
All kinds of FLEXIBLE CABLE. For Controlling, for Electric Lights, and for Annunciators in ELEVATORS
Also for Theatre and other trying work
BISHOP GUTTA-PERCHA COMPANY
422-426 EAST 25TH ST., NEW YORK

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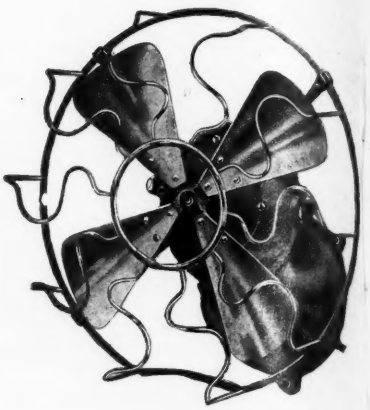
LINCOLN

was right when he said

"A man can not be too careful about forming new habits after he is thirty years of age. Most men have all the habits they can afford at that age. It is the part of wisdom after that time to get rid of habits and form principles."



It is all very well to experiment with electrical fans for a certain length of time, but you will soon come to the conclusion that it is the best policy to place your money on certainties.

You will find it best to buy fans of established reputation and record for all round usefulness.

WHEN YOU BUY

Colonial Fans

you buy our experience with the trouble and experimenting left out. When the weeks come and go and no one "registers a kick" against this or that point about COLONIAL FANS, we conclude that the "COLONIAL" comes very close to being "JUST EXACTLY RIGHT." If it wasn't, we'd hear about it quick.

In the place of adverse comment, we get nothing but words of commendation, and it would seem as tho' the fact that others are so well pleased will serve to influence you toward an investigation of what we naturally think is the best fan made, and we shall be pleased to have your inquiries and to afford full details.

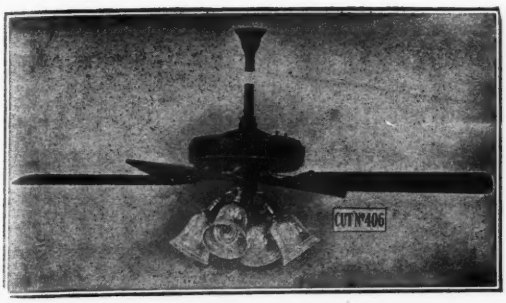
They are made in a variety of desk, bracket and ceiling types. Made in all finishes—and all first quality as to workmanship and materials.

THE COLONIAL FAN AND MOTOR COMPANY

Warren, Ohio U. S. A.

Direct-Current Power Motors and Generators; motor-generator charging sets for telephone and automobile use; rotary converters for telephone ringers and X-ray apparatus

ALL KINDS OF
FANS



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Also ask for Bulletins on
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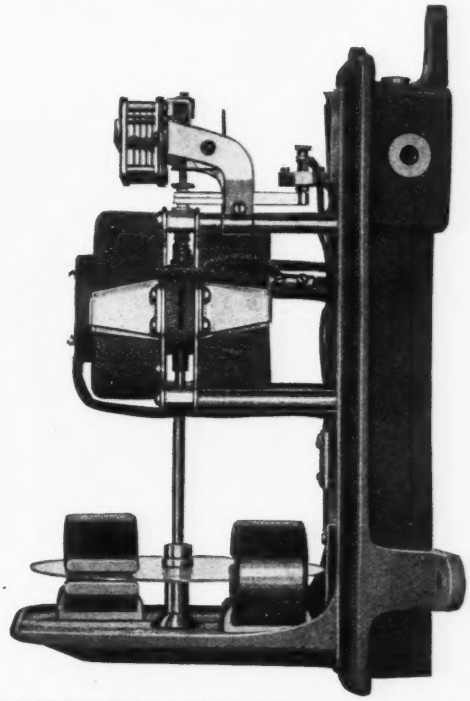
By All Unbiased Meter Experts to Be the Most Reliable Direct-Current Wattmeter in the World



DUNCAN ELECTRIC MFG. CO., Lafayette, Ind., U.S.A.

DON'T OVERLOOK THE FACT THAT WE ARE THE
PIONEERS IN THE ENCLOSED FUSE INDUSTRY

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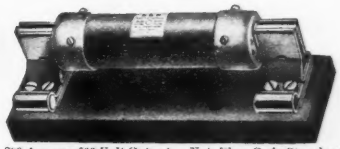
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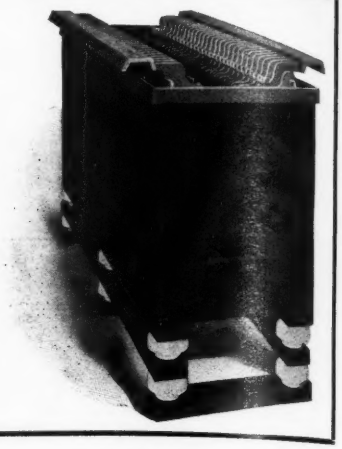

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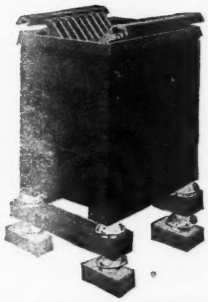

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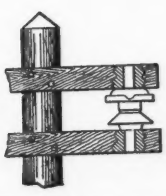

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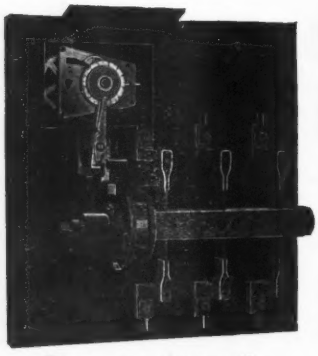

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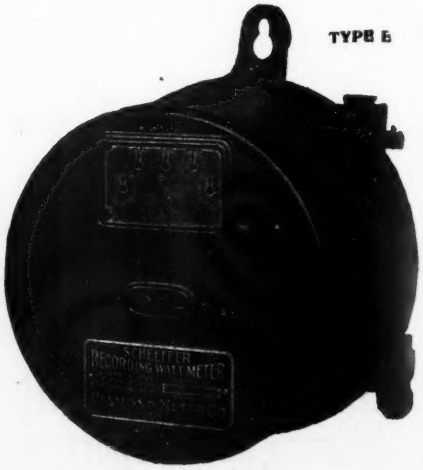

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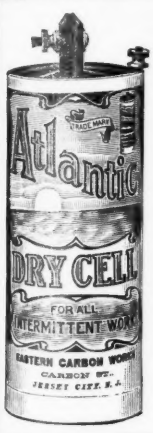

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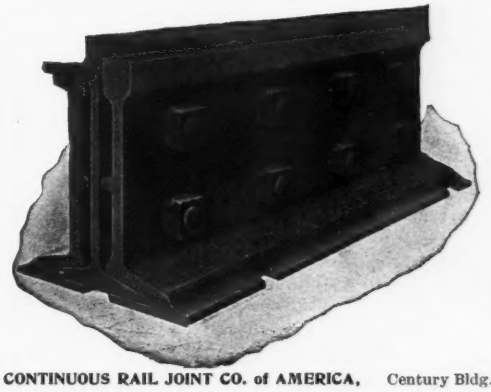

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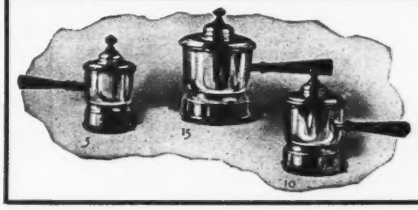

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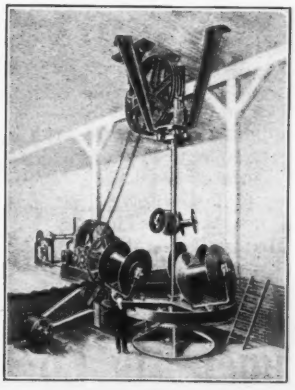

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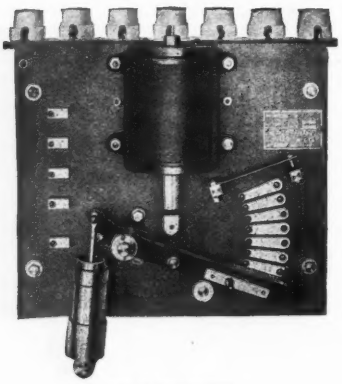

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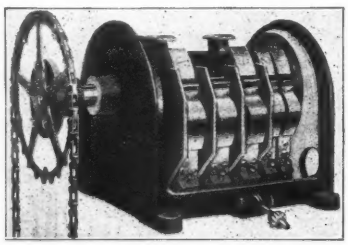

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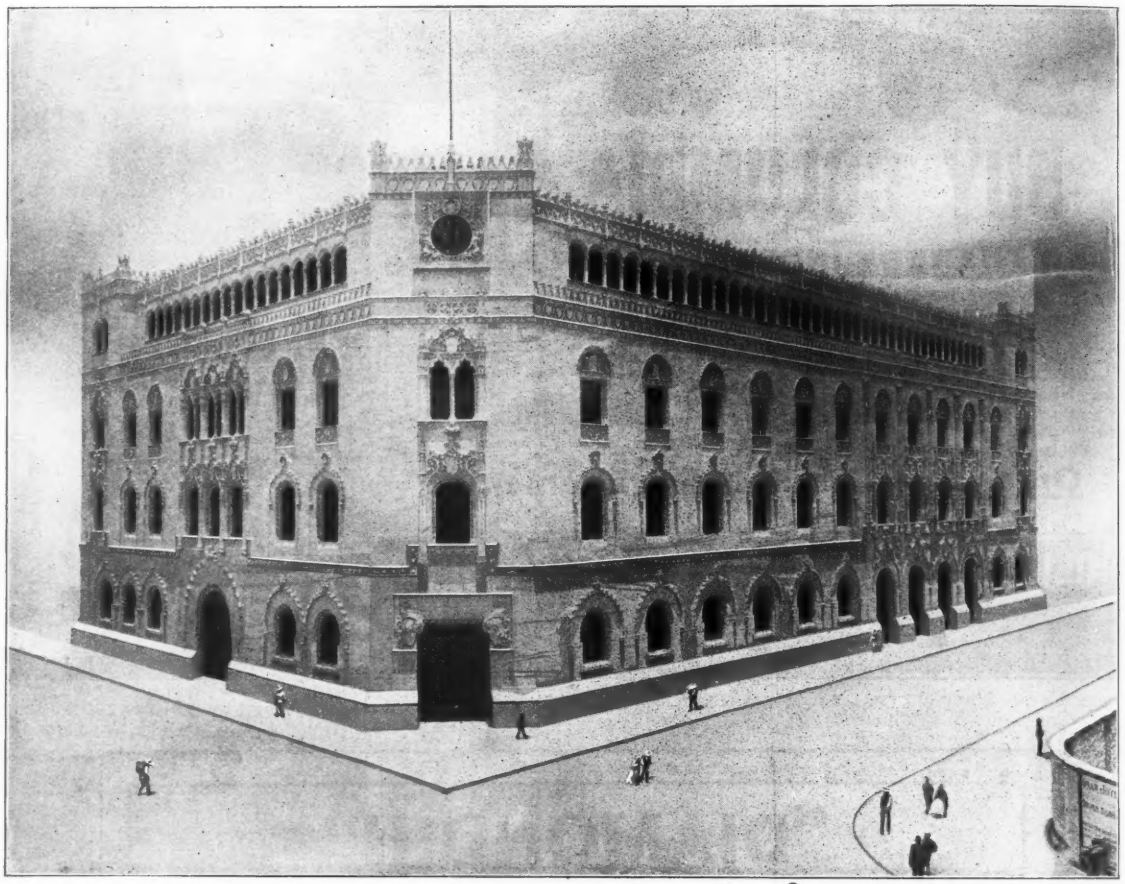

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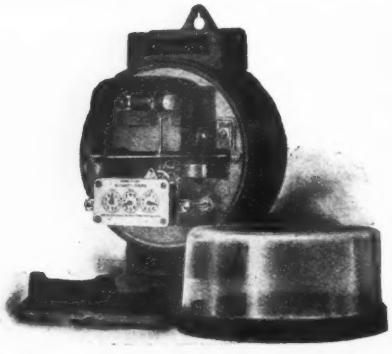

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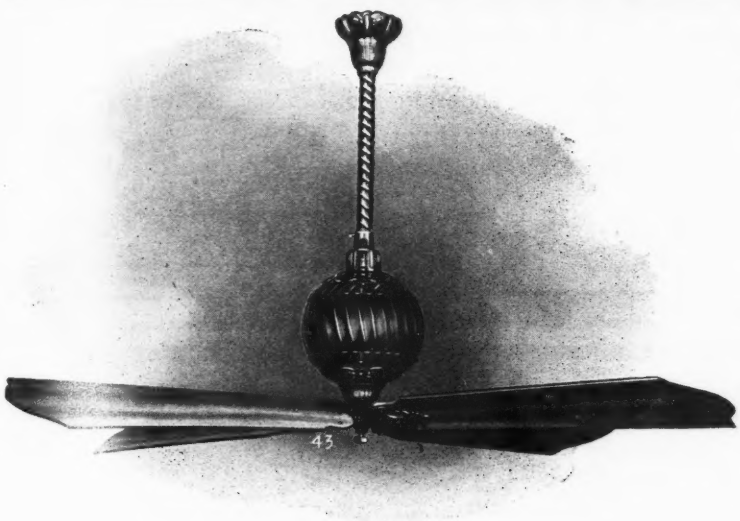

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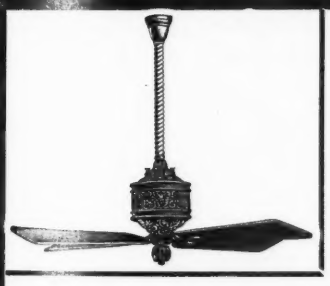

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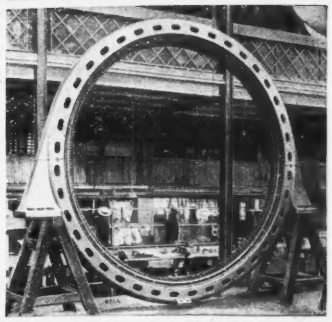

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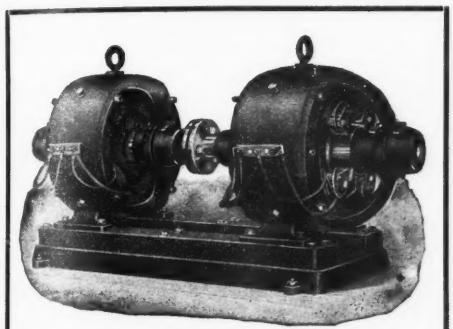

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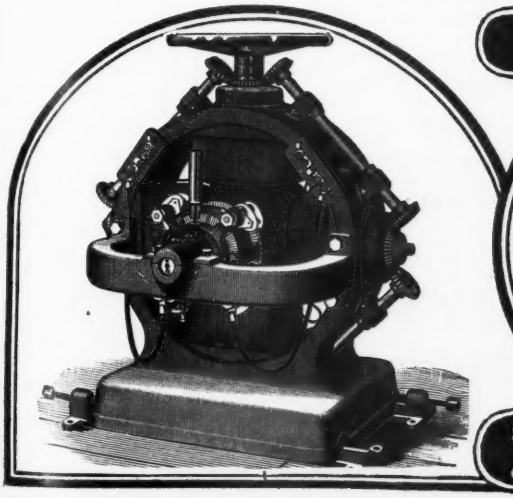

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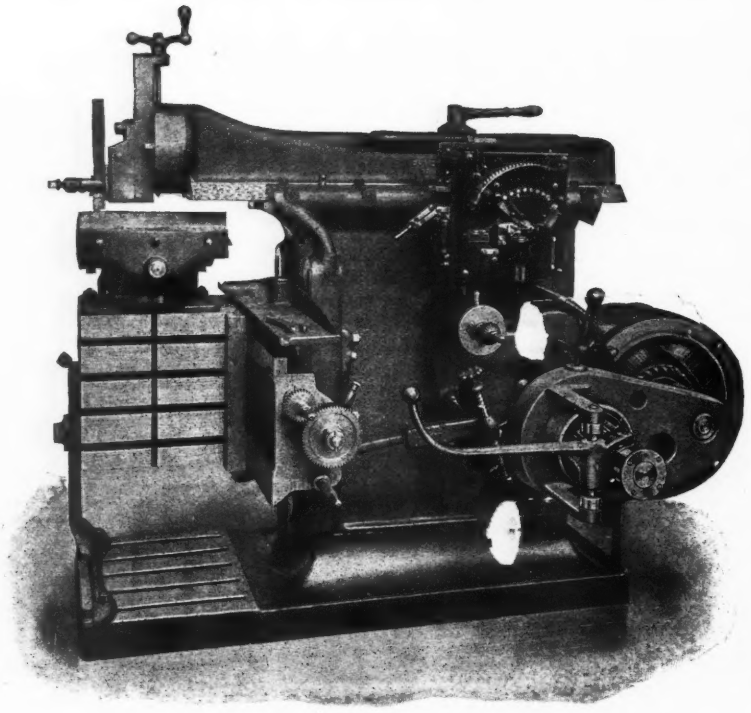

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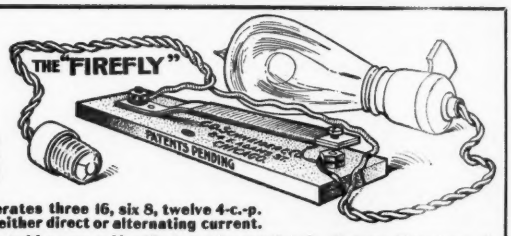

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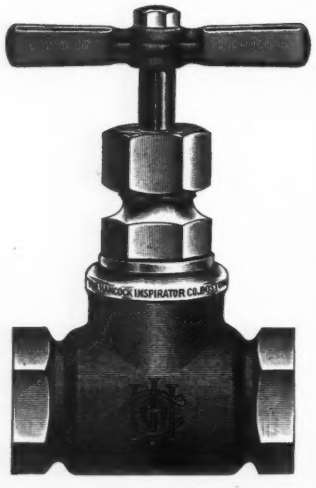

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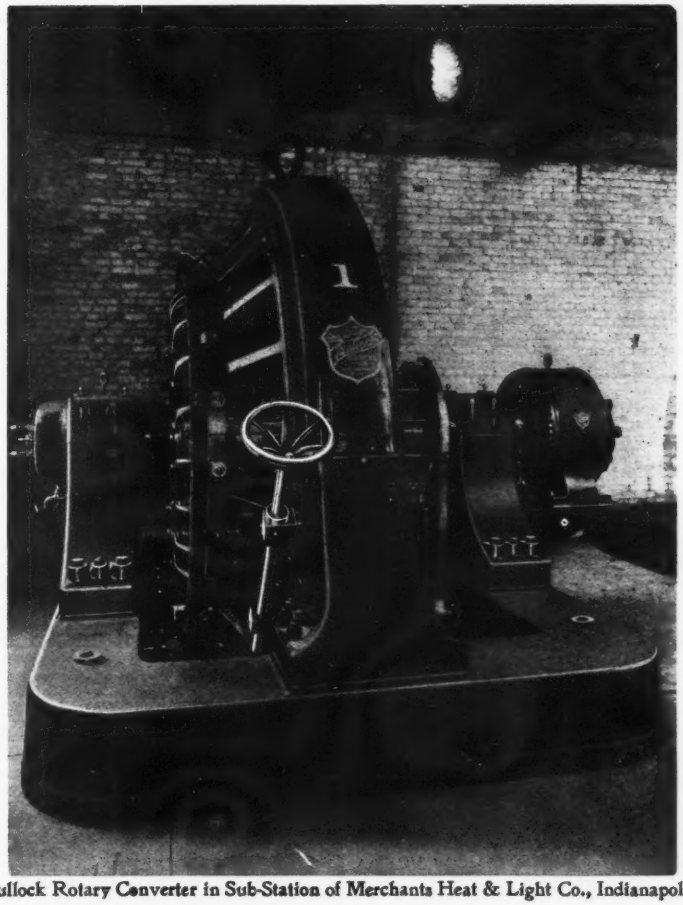

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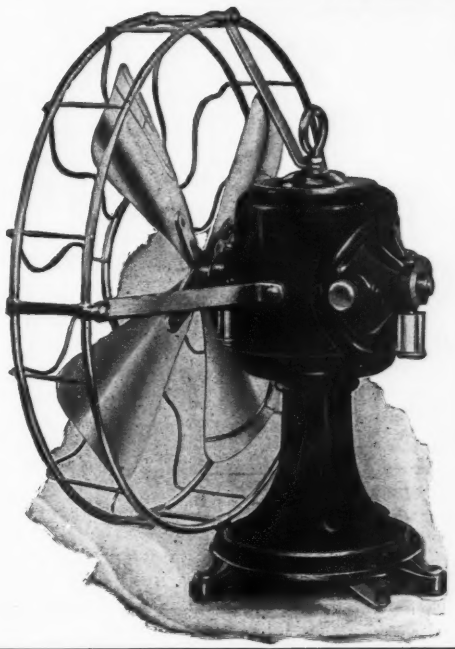

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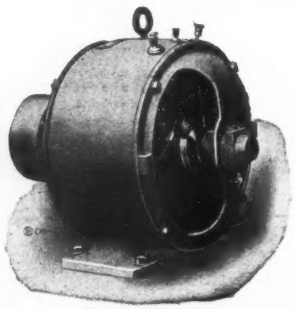

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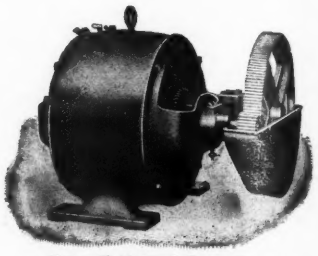

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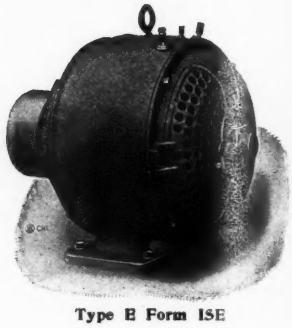

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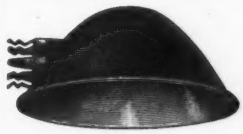

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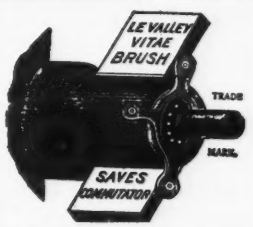

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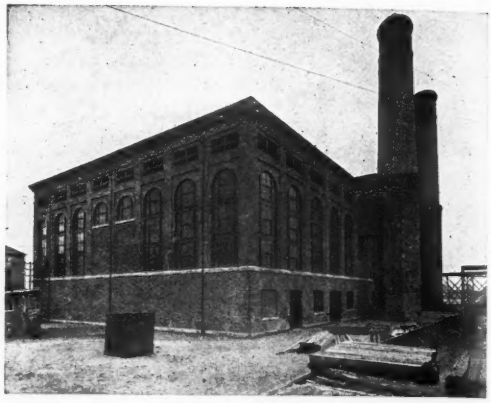
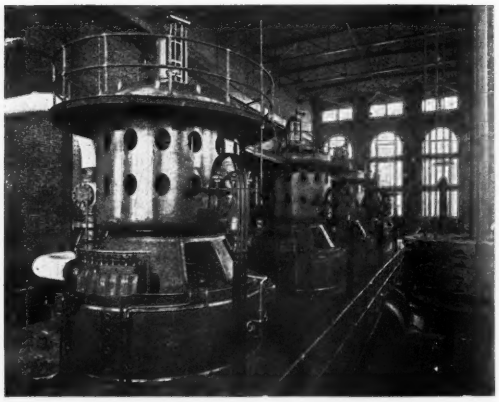
The model railway power station of today is a simple combination of Curtis Steam Turbine Generators, G. E. three-phase transformers and rotary converters, all controlled from a central switchboard equipped with G. E. instruments and high-tension oil switches





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(622)

General Electric Company

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High Efficiency

High Candle-Power

Incandescent Units

Efficiency superior to all other commercial electric illuminants.

New GE Incandescent Unit with DISTRIBUTING OR "D" FORM OF SHADE

Table of Sizes and Values		
Type No. of Lamp	Total Watts	Distributed Candle-Power in Dowaward Direction
3	125	70
4	187½	105
5	250	140

New GE Incandescent Unit with CONCENTRATING OR "C" FORM OF SHADE

Table of Sizes and Values		
Type No. of Lamp	Total Watts	Concentrated Candle-Power in Downward Direction
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4	187½	180
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GREEN'S ECONOMIZER

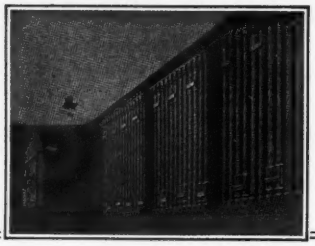
Gives 20 per cent to 40 per cent More Steam

Keeps a large volume of water above the boiling point always available in case of sudden demand for extra power, or other emergencies.

Uses waste gases entirely.

Designed for high or low pressure, natural or mechanical draft.

We Build and Install Mechanical Draft Plants



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Exhausters
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Applied to 365,000 boilers, equal to 35,000,000 B. H. P.

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Matteawan, N. Y.

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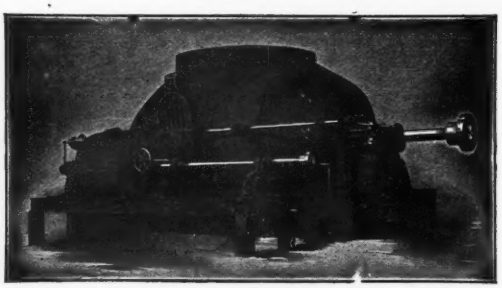

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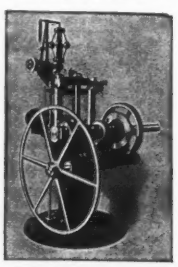

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We make governors for all types of water wheels working under all conditions. You will find them in use everywhere. We guarantee them to be unequalled.

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CALL ON THIS COMPANY
IT WILL PAY YOU

6

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Electric Light Supplies

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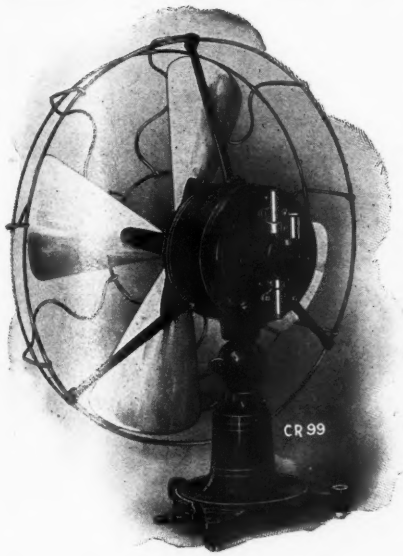

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is the best Fan to carry in stock. By simply loosening a thumb screw it becomes either a Desk or Bracket Fan, and when used in either position its air current may be directed in any direction or at any angle of elevation.

The quality is all that could be desired. We can make immediate delivery and the price is low.

We make ten other models of Ceiling, Desk, Bracket and Oscillating Fans, covering practically every requirement in this line.

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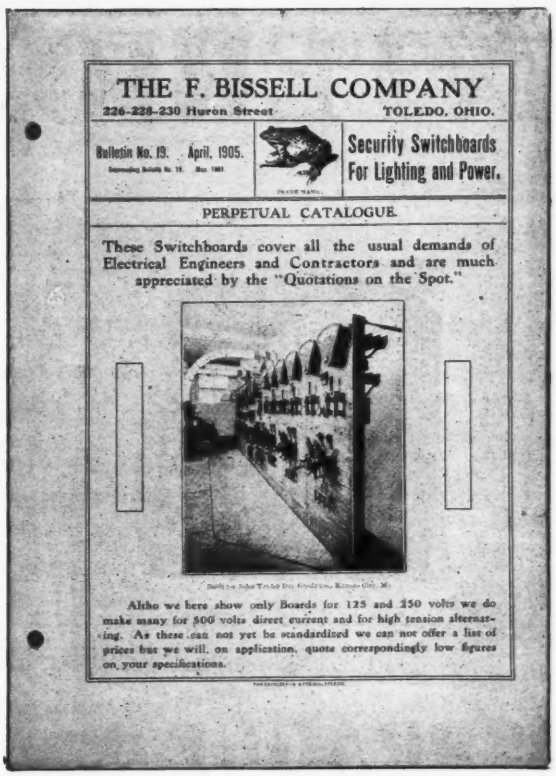
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Bulletin No. 19. April, 1905.

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Altho we here show only Boards for 125 and 250 volts we do make many for 500 volts direct current and for high tension alternating. As these can not yet be standardized we can not offer a list of prices but we will, on application, quote correspondingly low figures on your specifications.

Contractors, Jobbers and Dynamo Builders make money with this free book

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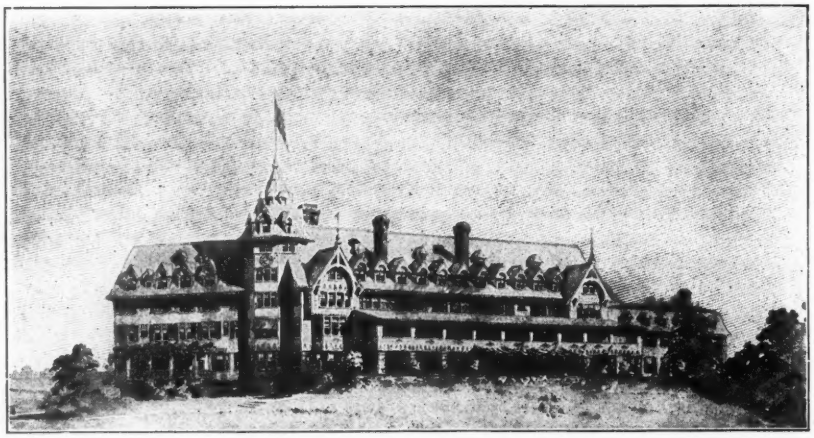

Edgewood Inn, Greenwich, Conn.

We manufacture a large variety of interior conduits for modern wiring in public and private buildings, cars, steamships, etc., and for each type of conduit we make a complete line of junction boxes, fittings and tools. Our products are specified by the leading architects and contractors because of their superior quality.

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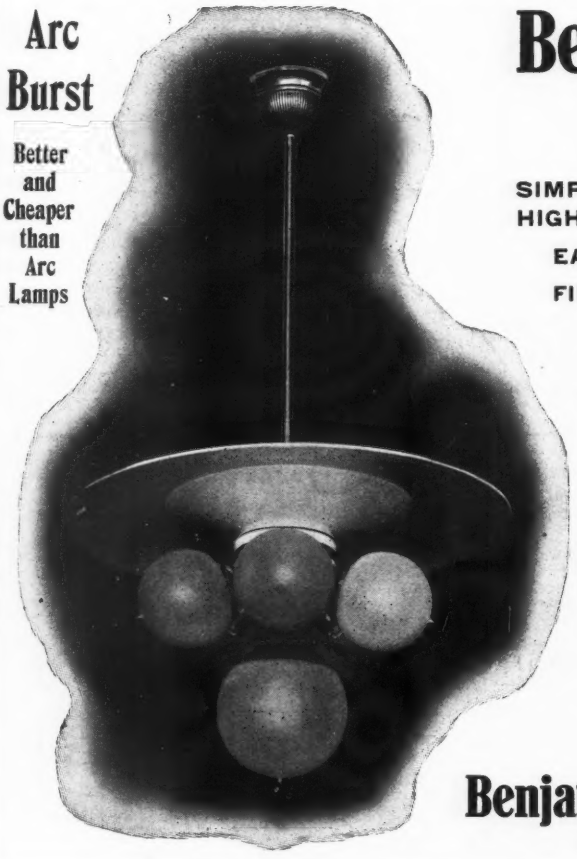

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NATIONAL CODE STANDARD

SIMPLE, STRONG AND HIGH INSULATION

EASILY CONNECTED

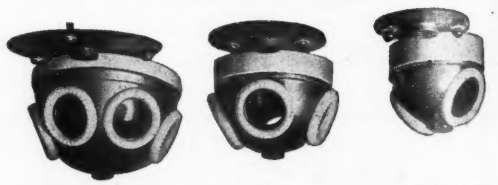
FIBRE LINED

ONLY TWO BINDING SCREWS

BENJAMIN MAKES THE BEST

Try the Arc Burst and Save Money

They go like hot cakes



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The celebrated open circuit battery which has maintained the same price and quality for eighteen years

4½ x 4½ x 8 inches

Samson carbons are manufactured in France.

No. 3 especially adapted for telephone work.

Insist that every element is the genuine "Samson."

Made in four different styles—Nos. 1, 2, 3 and Samson Semi-Dry.

Not cheapest, but least expensive.

Beware of the many imitations. Tests prove it.

We solicit correspondence regarding any of the different styles. Pamphlets upon request.

FOR SALE BY

F. D. Lawrence Electric Co.

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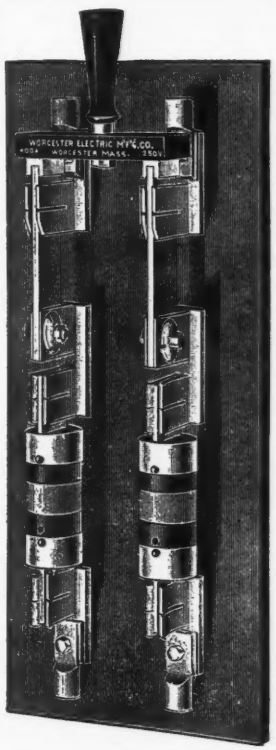

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AT THE

INTERNATIONAL ELECTRICAL EXHIBITION

We will exhibit a fine line of High-Grade Knife Switches, Switchboards, Panel-Boards, etc. Our Stand will be at section No. 85, near main entrance.

In the meantime write and get our catalogues, also Bulletin No. 5 with prices on Switches and Fuse Blocks arranged for New Code Fuses.

They are the BEST.

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Nearest Hotel to the National Electrical Contractors' Convention

and two to three minutes' walk from Huntington Avenue Station of Boston & Albany Division of New York Central, and Back Bay Station of New York, New Haven & Hartford Railways. All trains stop at these stations.

A First-class Hotel at Reasonable Prices

European Plan $1.50 Per Day and Upwards

Long-distance Telephone in Every Room AMOS H. WHIPPLE, Proprietor

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TRADE MARK ELECTRICAL SARCO SPECIALTIES.

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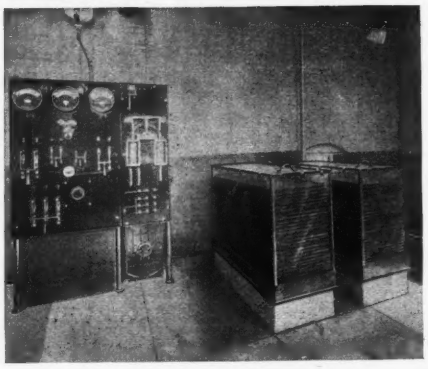
"WE'LL LEAVE IT TO YOU"

THE BATTERY
THAT PRODUCES RESULTS

BETTER AND MORE SATISFACTORY SERVICE
Very Compact—Large Contact Surface, eliminating internal resistance
THE TRAY PLATE BATTERY is known for its exceedingly Low Resistance, Economical Operation, and as a Saver of Fuel is without an equal

LARGELY INCREASED CAPITAL AND BETTER FACILITIES enable us to supply all orders promptly



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We also manufacture an IMPROVED CELL TYPE BATTERY in All General Styles for All Purposes, including Electrical Vehicle Batteries.
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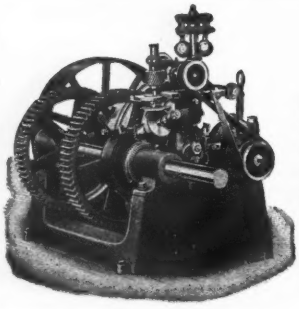

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must govern or it is worse than useless. Hundreds of our Compensating Governors are in successful use on power and lighting plants. They must be good.
Let us send you our catalogue

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P&B ELECTRICAL COMPOUNDS
STANDARD FOR 19 YEARS
MANUFACTURED BY
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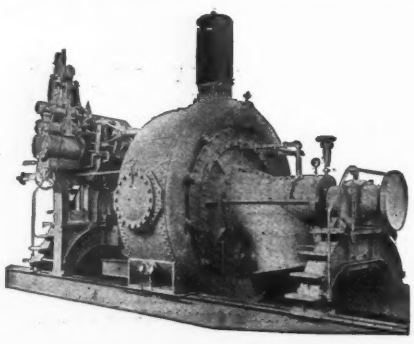


SAMSON TURBINE

The illustration shows the large NIAGARA design, HORIZONTAL SHAFT TURBINES recently installed by us for the NIAGARA FALLS HYDRAULIC POWER & MANUFACTURING CO., Niagara Falls, N. Y. Tests conducted by competent engineers developed as follows:

Head	Gateage	Speed	H.-P.	Generator Efficiency	Turbine Efficiency
213 ft.	1-2	257 r.p.m.	1750	95 per cent	73.00 per cent
213 "	3-4	257 " "	3000	95 " "	85.60 " "
213 "	Full	257 " "	3500	95 " "	81.50 " "

These results have never been equaled by any turbine of the Horizontal Shaft Design, operating under equally HIGH HEADS. The test was made AFTER TURBINES WERE INSTALLED, direct coupled to Generators. Francis' weirs and formulæ for discharge were used. The original test reports on file at our offices. These turbines are all fitted with our SAMSON BALANCED GATES. Note especially the UNIFORM SPEED AT ALL GATEAGES.

JAMES LEFFEL & CO., No. 309 Lagonda St. SPRINGFIELD, OHIO, U. S. A.

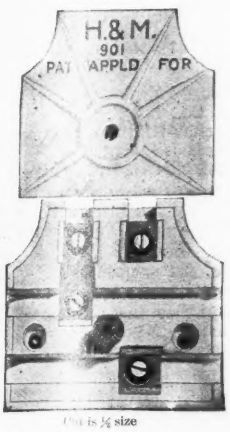
SOMETHING NEW

The "H. & M." Moulding Branch Blocks

MANUFACTURED IN SIX STYLES

EACH BLOCK PACKED IN A NEAT PAPER BOX

LIST NO.								STD. PKG.
901	2	WIRE	MAIN	TO	SINGLE	2	WIRE BRANCH	100
902	2	"	"	"	DOUBLE	2	" "	100
903	3	"	"	"	SINGLE	2	" "	100
904	3	"	"	"	DOUBLE	2	" "	50
905	3	"	"	"	SINGLE	3	" "	50
906	3	"	"	"	DOUBLE	3	" "	50



Cut is ½ size

By using the "H. & M." Moulding Branch Blocks, all disadvantages in making branches are done away with. Time is saved, simply place the blocks where branches are desired. The main line of moulding can be completed, and branches finished afterwards. By the old method, branches have to be spliced before main line can be finished. **Consider these advantages.** Write to-day for prices, discounts, etc., to your jobber or to the manufacturers.

NO cutting of moulding to accommodate joints.
soldering of joints.
exposed wire.
danger of fire from loose joints.
time lost in installation.

The Elm City Engineering Company
61-65 Orange Street, New Haven, Conn.
Approved by the Underwriters' National Electrical Association

THERE'S GOING TO BE TROUBLE IF LIGHTNING COMES YOUR WAY.

Of course, it can't be stopped, but it can be prevented from going through an electric system.

GARTON LIGHTNING ARRESTERS

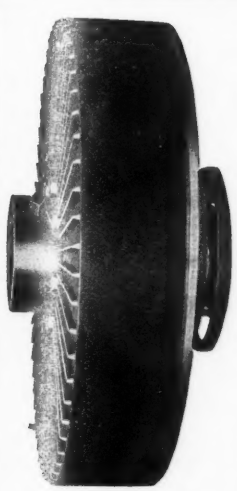
make the lightning harmless as far as your line and station are concerned. They tame the wildest flash that ever came to earth.

The remarkably small air-gap they employ affords a path for the lightning that it seems unable to refuse. The best method of distribution to secure reliable results is given in our Booklet "An Easy Way."

SEND FOR IT TO-DAY.

Note—Garton-Daniels Lightning Arresters are included in the April issue of "Approved List of Fittings" published by the National Board of Fire Underwriters.

GARTON-DANIELS CO.
KEOKUK, IOWA



ONE . . .

Central Problem

The Accelerator Solved

The Accelerator solves many problems of automatic and remote control.

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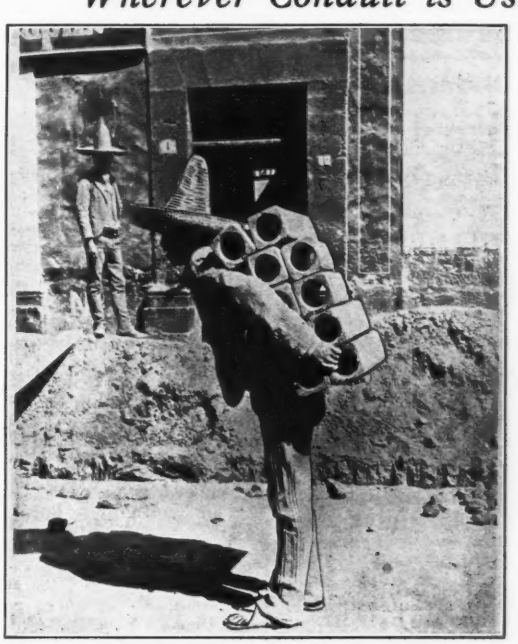

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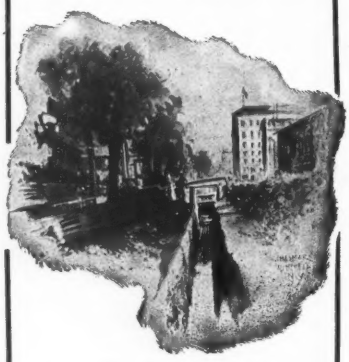

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Platt Iron Works Co.

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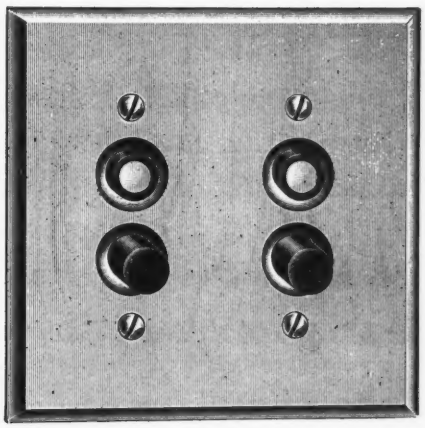

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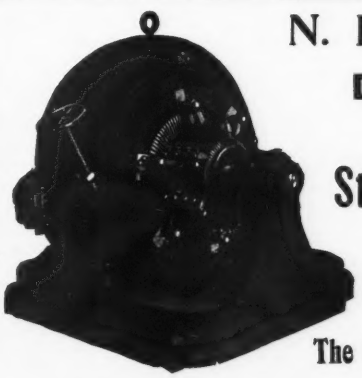

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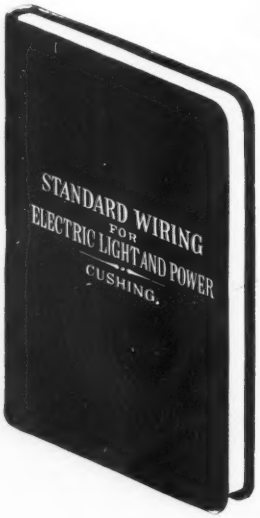

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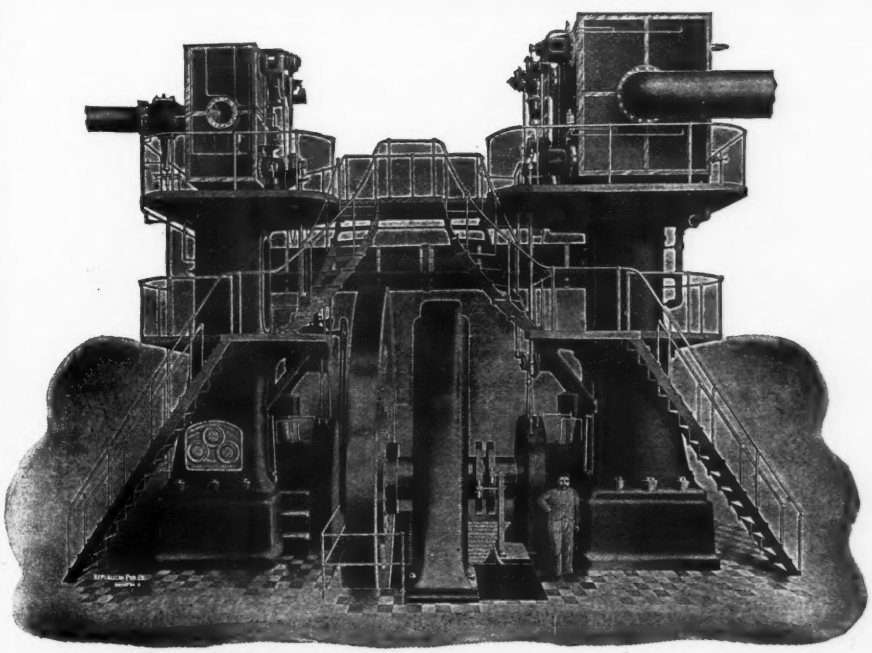

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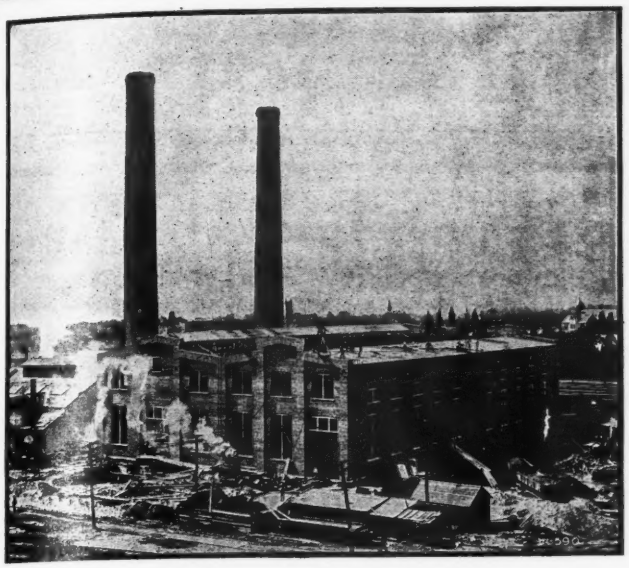

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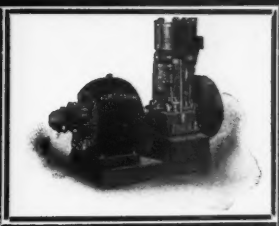

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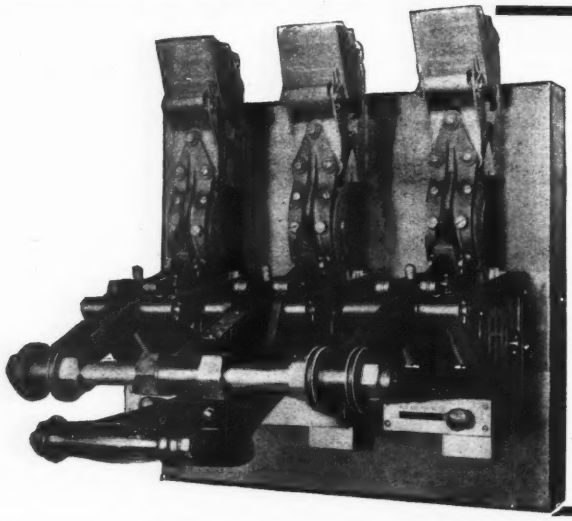

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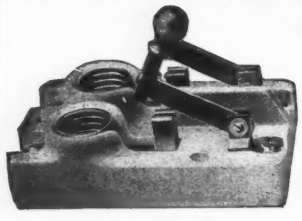

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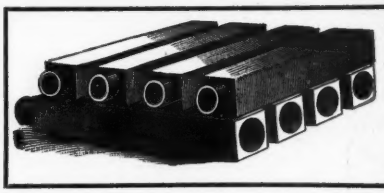

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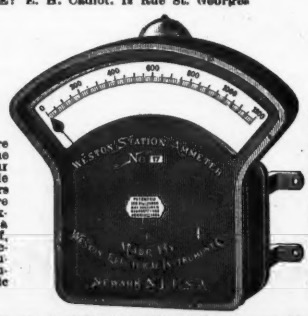

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793,060 Electric time-switch; M. Danziger, Gleiwitz, Germany.

793,063 Electrical instrument; J. J. Ghegan, Newark, N. J.

793,065 Rotary snap-switch; M. Guett, Hartford, Ct.

793,066 Electric switch; M. Guett, Hartford, Ct.

793,076 Anode plates for batteries; H. C. Hubbell, Jersey City, N. J.

793,077 Cathode plates for batteries; H. C. Hubbell, Jersey City, N. J.

793,078 Cathode plate for batteries; H. C. Hubbell, Jersey City, N. J.

793,083 Apparatus for indicating the positions of moving targets; J. F. Meigs, South Bethlehem, Pa.

793,093 Battery grid; H. C. Porter, Waukegan, Ill.

793,112 Vacuum tube; R. V. Wagner, Chicago, Ill.

793,117 Storage battery jar; T. S. Witherbee, Jersey City, N. J.

793,118 Electric water heater; A. D. Wright, Seattle, Wash.

793,137 Electromagnetic ore separator; E. Langguth, Euskirchen, Germany.

793,138 Electrolytic decomposition of saline solutions; A. B. Lockhar, Oldtown, Me.

793,143 Jump-spark apparatus; H. C. Mueller, Fon du Lac, Wis.

793,158 Electric heater; C. A. Rolf, Adrian, Mich.

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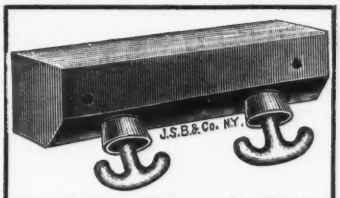

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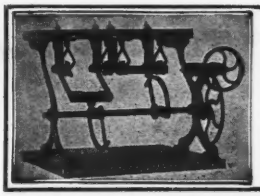

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793,188 System of electrical distribution; C. M. Green, Lynn, Mass.

793,197 Flush attachment-plug receptacle; H. Hubbell, Bridgeport, Ct.

793,211 Method of and apparatus for finishing electric lamps or bulbs; George McDonnell, St. Louis, Mo.

793,218 Speed-reducing device for motors or dynamos; J. G. O'Kelly, Chicago, Ill.

793,223 Igniter for combustible vapor engines; W. J. Perkins, Grand Rapids, Mich.

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793,229 Heating device for curling irons or the like; C. A. Rolfe, Adrian, Mich.

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793,245 Automatic block signaling system; H. B. Taylor, East Orange, N. J.

793,282 Elevated railway; Jacob Derx, St. Louis, Mo.

793,295 Cutting machine; J. B. Gurry, St. Louis, Mo.

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793,344 Trolley base; Peter Best, Elizabeth, N. J.

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793,424 Electric oven; L. E. Custer, Dayton, Ohio.

793,429 Electrically operated hydraulic valve; C. Engberg, St. Joseph, Mich.

793,430 Trolley; D. C. Evans, Uniontown, Pa.

793,436 Ear-piece or acoustic device; P. C. Green, Philadelphia, Pa.

793,440 Arc lamp yoke; C. E. Harthan, Lynn, Mass.

793,444 Micotelephone; K. Hofflinger, Vienna, Austria.

793,445 Lightning arrester; T. J. Johnston, Brooklyn, N. Y.—The com-

(Continued on page 54.)

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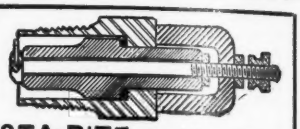
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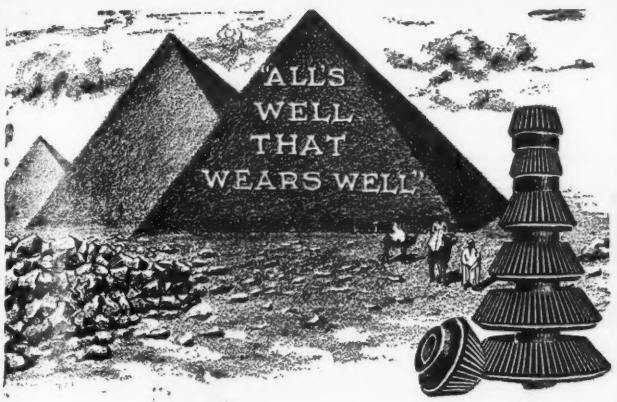

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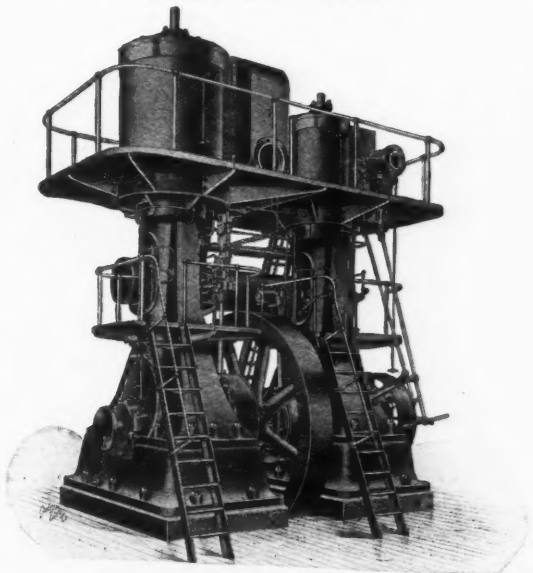

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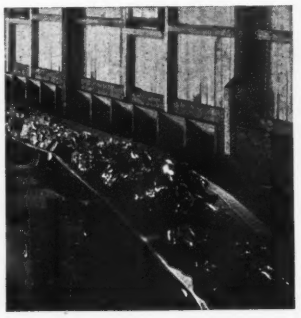

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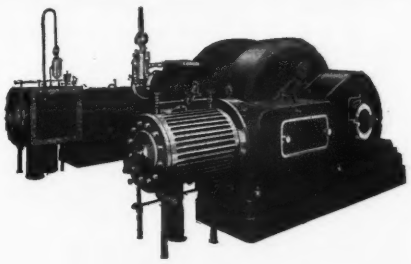

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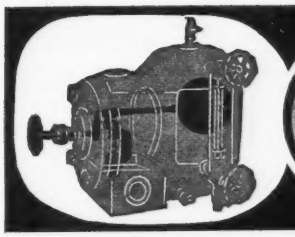

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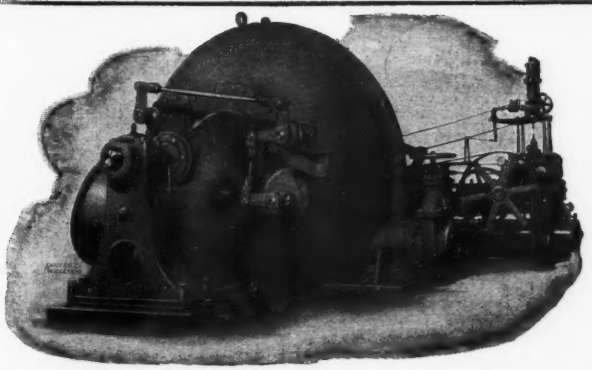

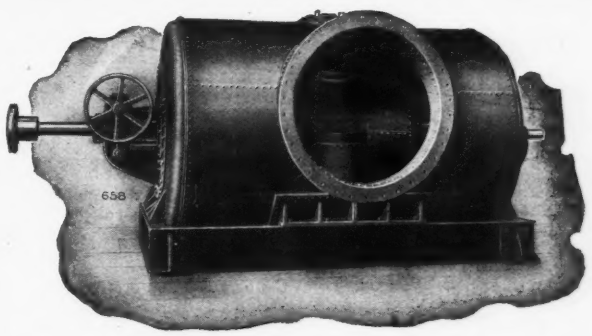

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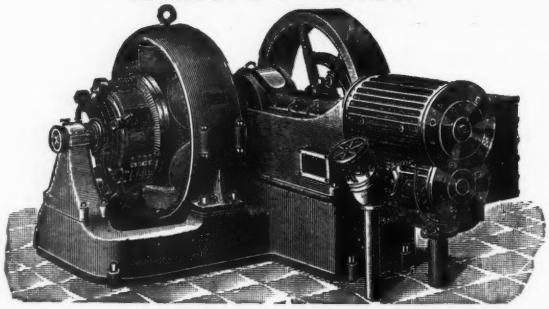

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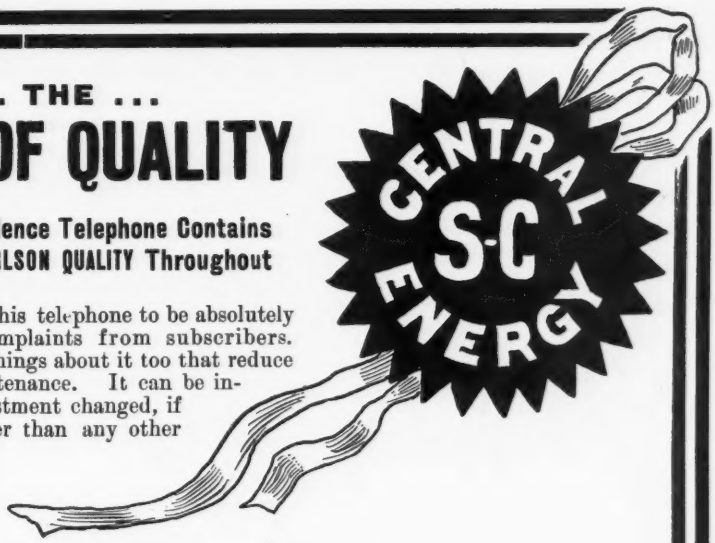

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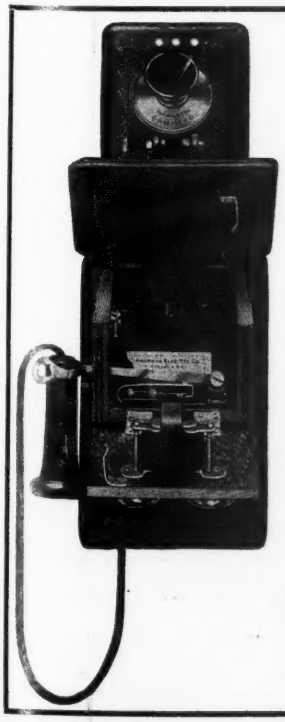

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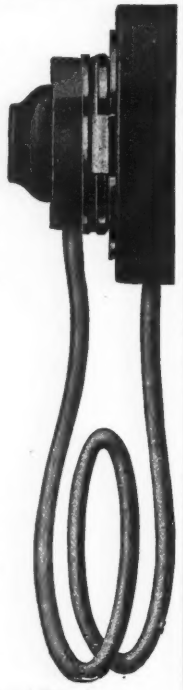

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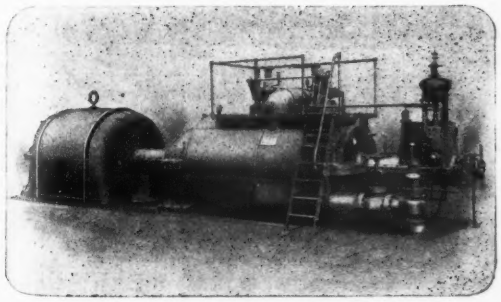

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CLASSIFIED INDEX PAGE 32

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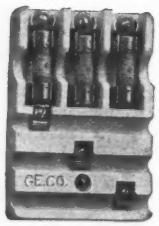
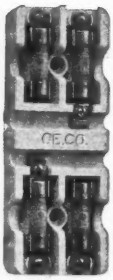


Three Wire, Single Branch, 30 Amp., 250 Volt Cutout.



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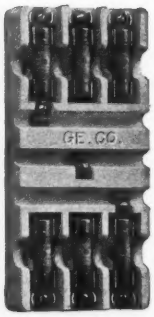

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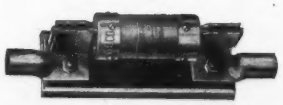

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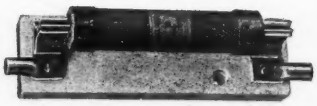

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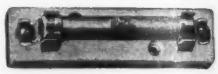

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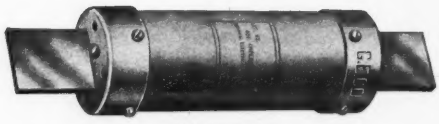

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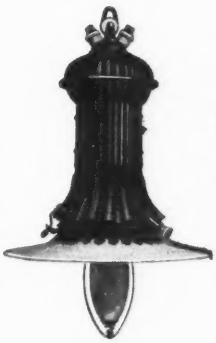

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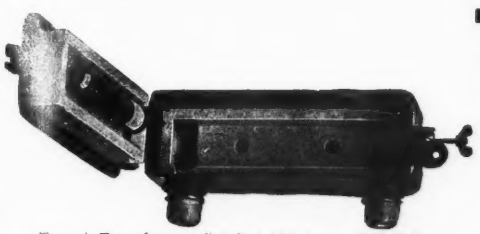

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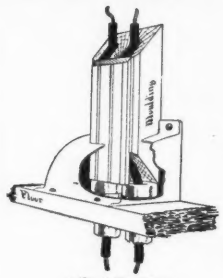
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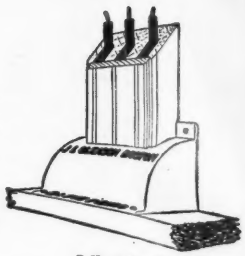
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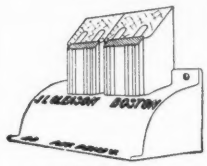
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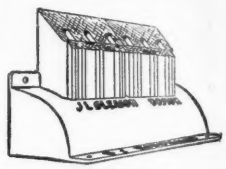
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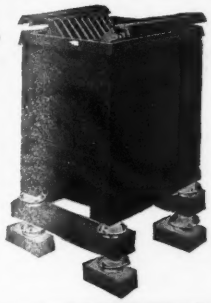

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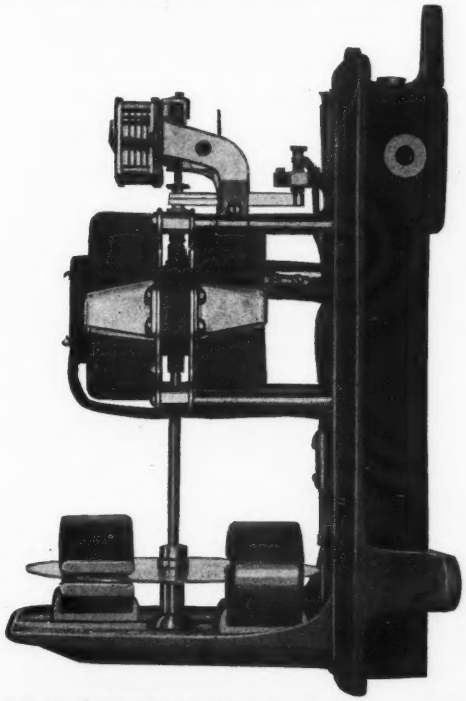

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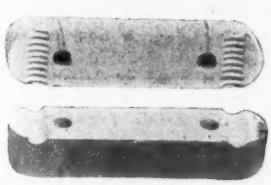

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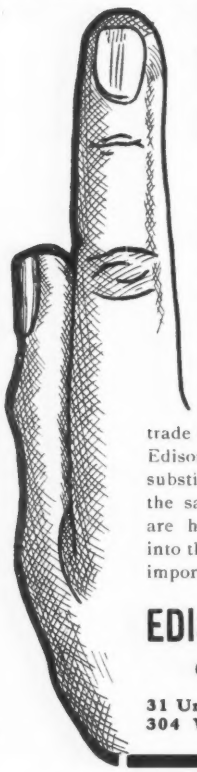

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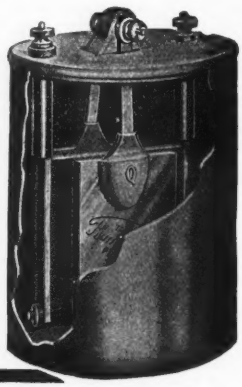

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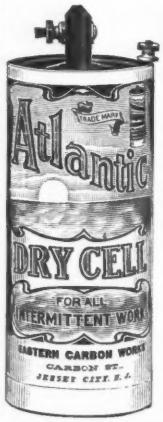

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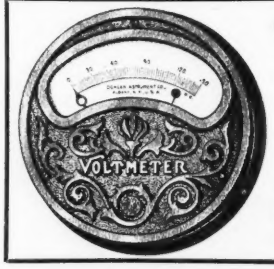

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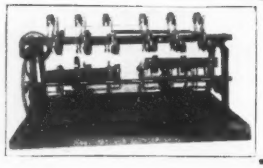

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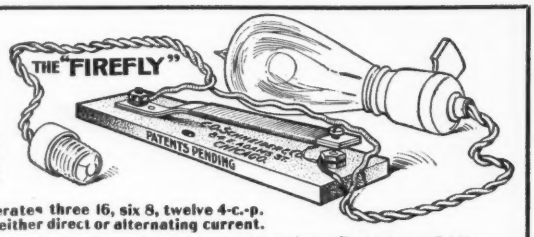

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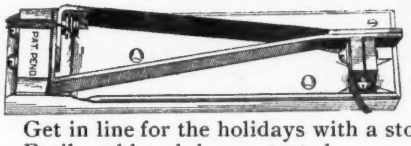

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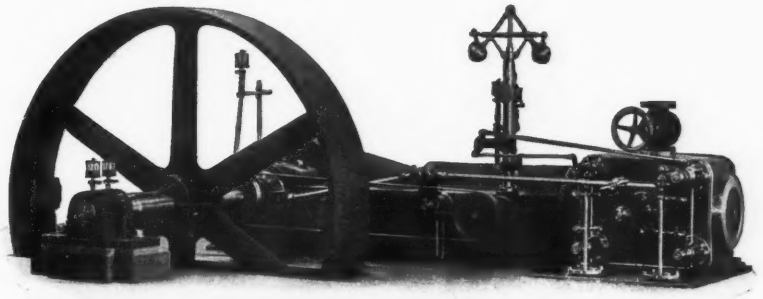

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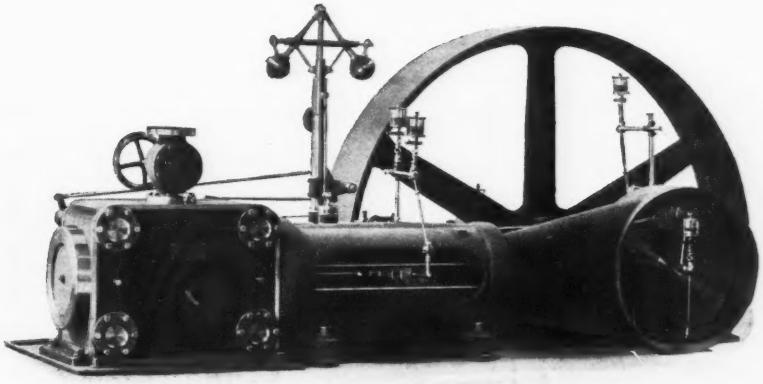

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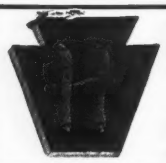

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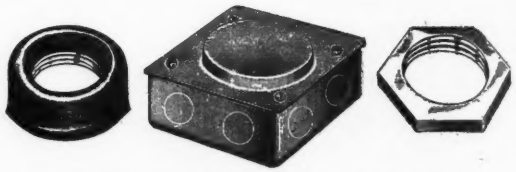

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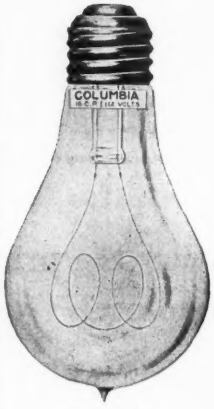

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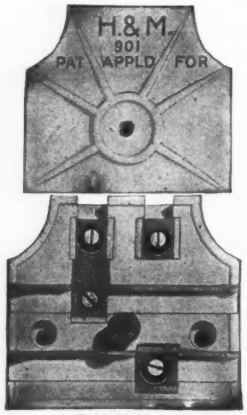
906	3	"	"	"	DOUBLE	3	" "	50



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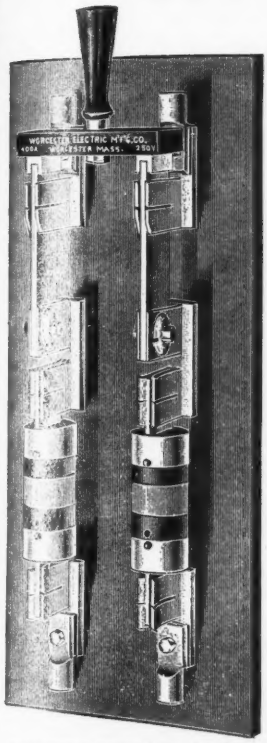

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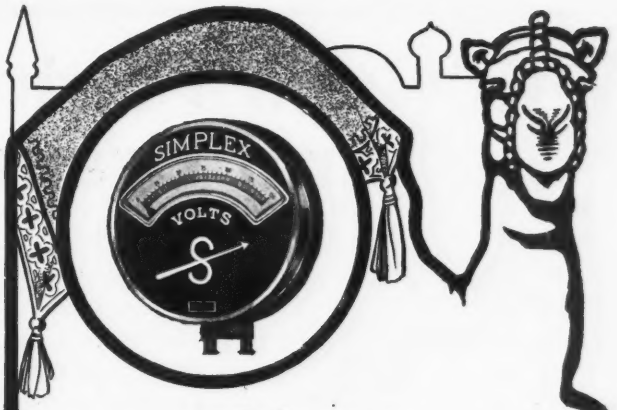

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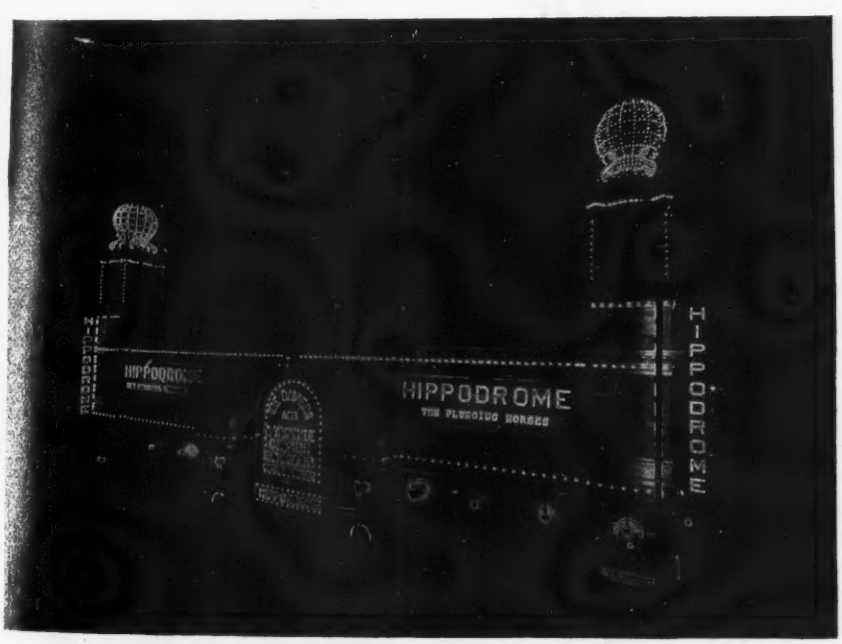

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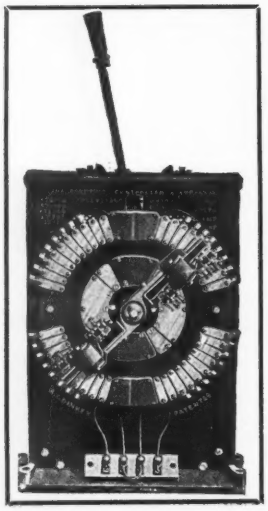

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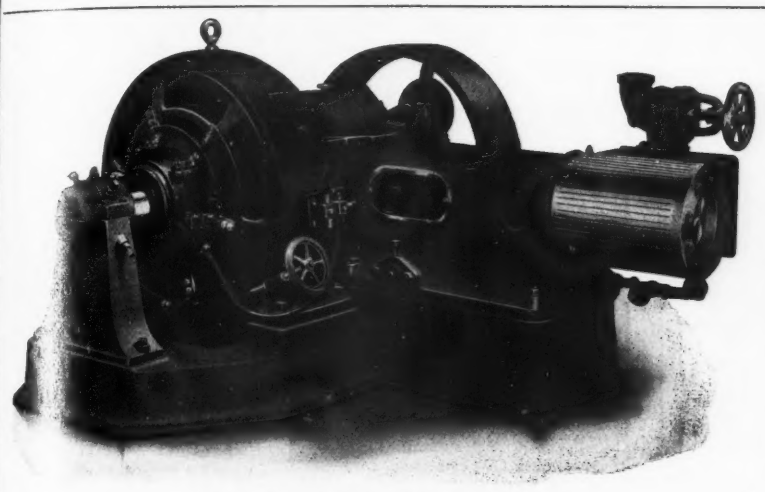

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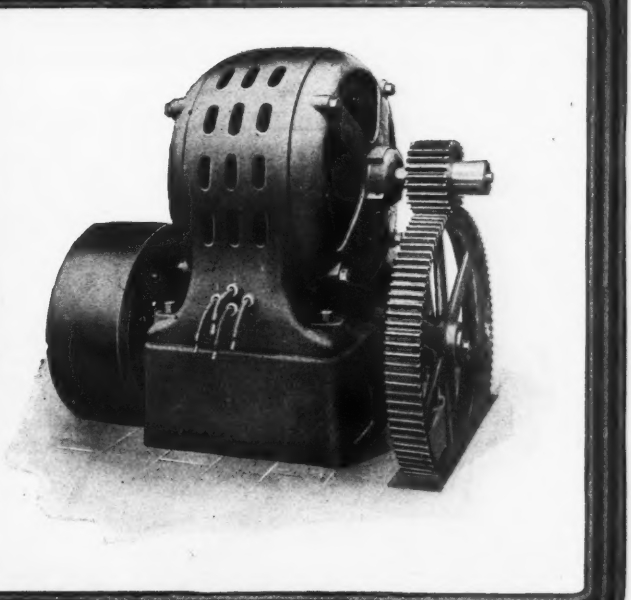

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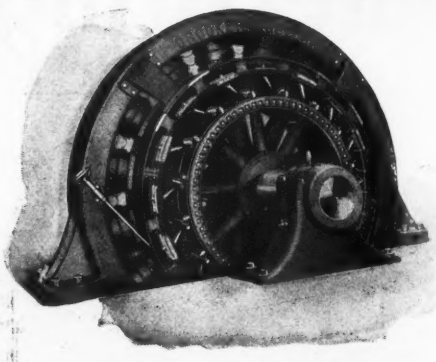

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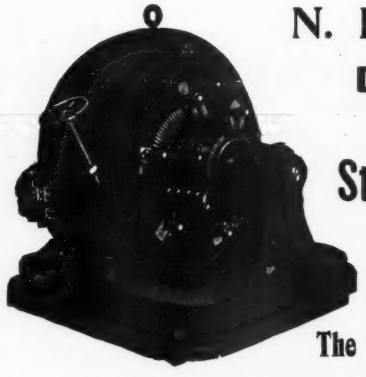

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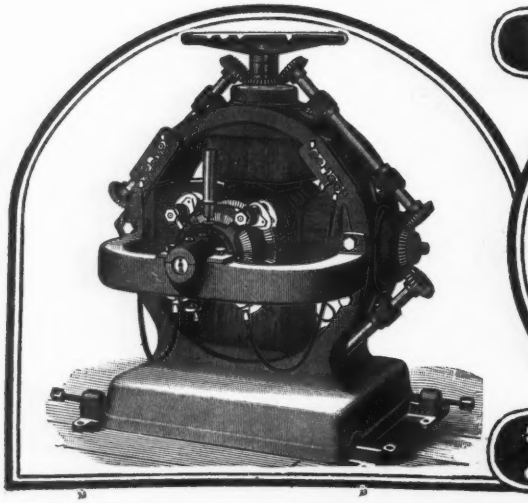

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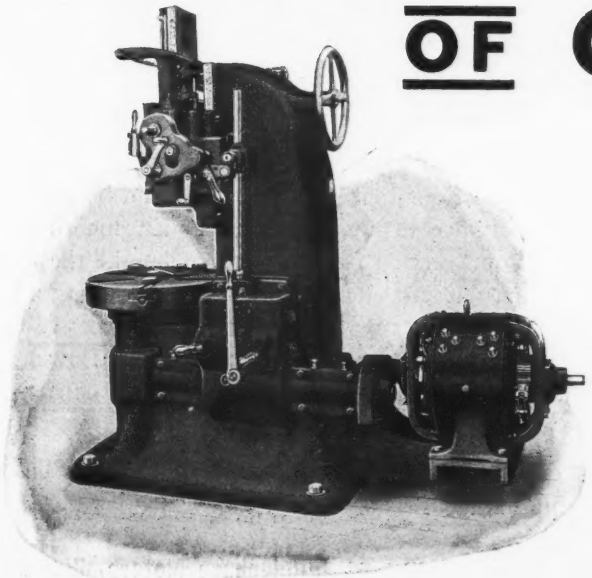

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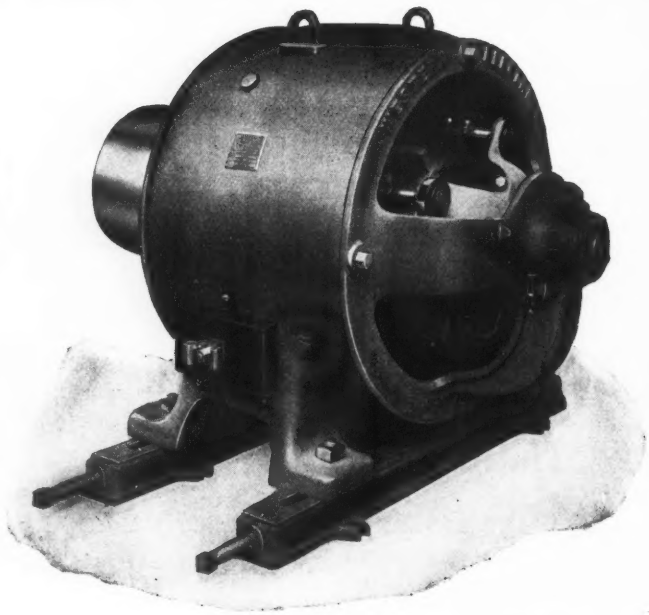

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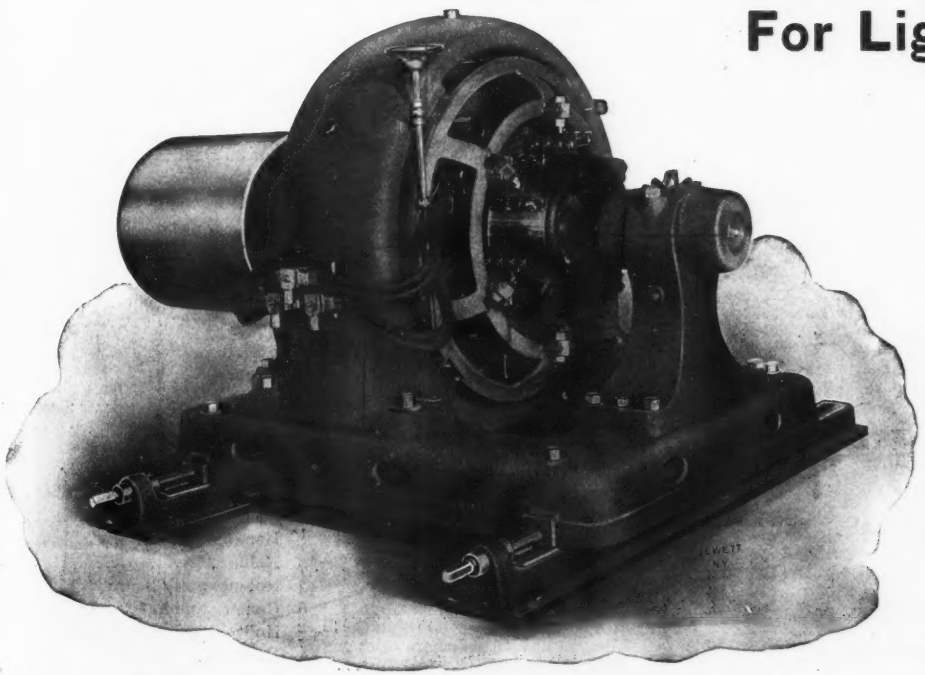

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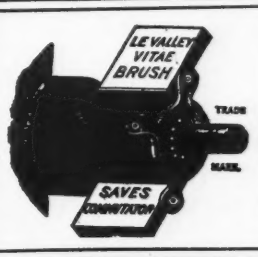

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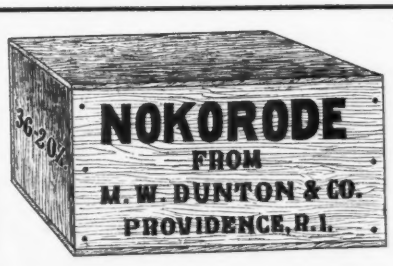

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Every branch of electrical development and progress will be discussed by eminent specialists. Among the subjects covered will be Electric Lighting, Electric Traction, Telephone Engineering, Wireless Telegraphy, Hydroelectric Development, Long-Distance Power Transmission, Electrochemistry, Electrometallurgy, General Scientific and Physical Development, Modern Theories and Historical Reviews.

In addition to this there will be descriptive articles of modern installation in many branches.

Our European review will be very thorough, and of particular value.

The reading pages will be elaborately illustrated and, besides all this, the regular news and industrial sections will be expanded so as to form a most comprehensive commentary on electrical conditions up to the date of issue.

ELECTRICAL

13 PARK ROW
New York City

Number

vast Electrical Industry, will appear

13, 1906

has been cleared away. In addition this number
as an authentic and authoritative

TRICAL PROGRESS

Value as an Advertising Medium

The circulation of the New Year's Number, January 13, 1906, will exceed, we believe, that of any other issue we have heretofore published. We are planning to meet the demand, which in previous years has been made on us for additional copies, by arranging extraordinary facilities in every department.

As the issue will be the regular Export and Domestic Number, the advertiser will receive the benefit of the extra foreign circulation.

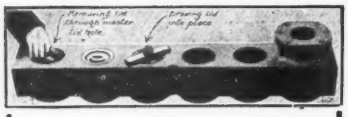
The advertising pages will constitute in themselves a comprehensive index of the electrical manufacturing industry. These pages will be unusually elaborate. The display will be such as will attract and hold attention, and because of their volume and completeness, the advertisements we know will be carefully studied by every reader.

In our art and engraving departments, advertisers will have the advantage of the largest force of skilful artists and clever ad-writers in the service of any technical publication. This department will assist and advise in the preparation of copy, free of charge.

Copy instructions may be sent to any of our offices. Early reservation of space will insure good locations.

REVIEW

Branch Offices: { **CHICAGO: 1501 Fisher Building**
BOSTON: 161 Devonshire Street
LONDON: 42 Old Broad Street



Recent Improvements in Economizers

ONE of the benefits resulting from the use of the Green Fuel Economizer is the purification of the boiler feed water, since heating the water causes carbonates of lime and magnesia to be precipitated. This makes it necessary to provide some means for getting at the interiors of the economizer tubes for inspection and cleaning.

One of the first improvements in the Economizer was, therefore, to provide handholes in the top header, one over each tube. With the low boiler pressures of that time it was found practicable to use external lids held in place by bolts and yokes, but with the high pressures now common it is better to use our patented conical lids, which are drawn tightly into place by a tee bolt, as shown above, and thereafter held by friction and the internal pressure. The joints are metal to metal, no gaskets or packings being used on the Economizer proper. Each header on which internal lids are used is provided with a patented master lid hole, through which the other lids may be removed without breaking the branch pipe joints

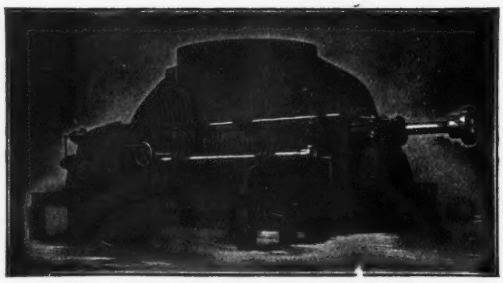
Little features like this, which usually come to light only through long experience, determine the profitableness of the economizer. Our experience dates from 1845. Send for our BOOK "ER" on Fuel Economy, and ask also for our Fan Catalog.

THE GREEN FUEL ECONOMIZER CO.

MATTEAWAN, - NEW YORK

(Sole Builders in this country)

22



PAIR

McCORMICK TURBINES

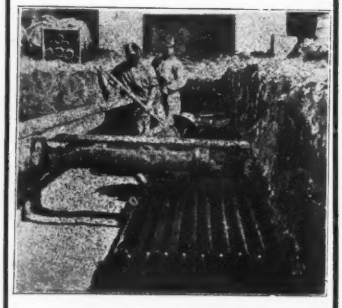
4000 H. P., 80 ft. head, arranged to drive generator and a single turbine to drive exciter. Seven settings built for the Hudson River Water Power Company's Spier Falls plant and 14 pairs 51 inch for their plant at Mechanicsville, N. Y.

Write for catalogue if contemplating purchase of turbines.

S. MORGAN SMITH COMPANY, YORK, PA., U. S. A. Branch Office: 176 Federal St., Boston, Mass.

Bituminized Fiber Conduit

For Underground Electrical Construction



The American Conduit Company has a corps of experts in underground construction and is prepared to furnish supervision of work if desired. We would prefer to co-operate with contractors in underground construction, but if desired will submit estimates and bids and take contracts for completed underground systems in any part of the United States or Canada.

AMERICAN CONDUIT COMPANY

Main Offices:
1005-1006 Manhattan Bldg., CHICAGO

Other Offices { 170 Broadway, New York
336 Macy St., Los Angeles

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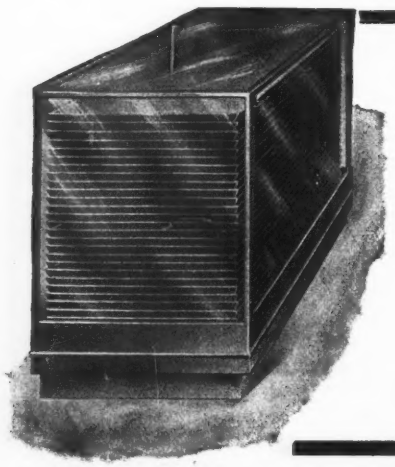
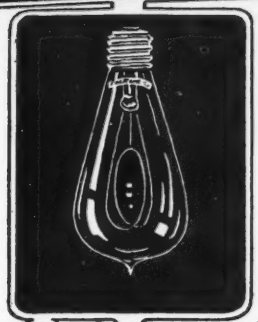


The Electro-Chemical Tray Battery

Can be placed where you like with no inconvenience whatever from vapors or gases. A battery so neat and companionable that you can invite it into your office should not be overlooked. It has capacity, too, and will sustain its rated current for eight or even ten hours with voltage up to two volts per cell, as shown by repeated tests. All sizes. Results and even satisfaction guaranteed under proper conditions. This is an important subject to all concerned. Does it interest you? We would be pleased to tell you more about it.

SMITH STORAGE BATTERY COMPANY, Sole Builders. **ZOAR, OHIO**

Packard



Lamps

BLOT OUT THE UNCERTAIN

Maybe you've had experience selling lamps of **uncertain illumination**—if so, you're the man we want to do business with. Poor illumination and enormous light bills have been cured in the last stages by a prompt application of

Packard Lamps

Some lamps start right and grow dim—others lead a long miserable existence.

PACKARD LAMPS not only start right, giving their full candle-power rating, but keep up their brilliancy throughout their entire life.

SEND FOR OUR NEW CATALOG

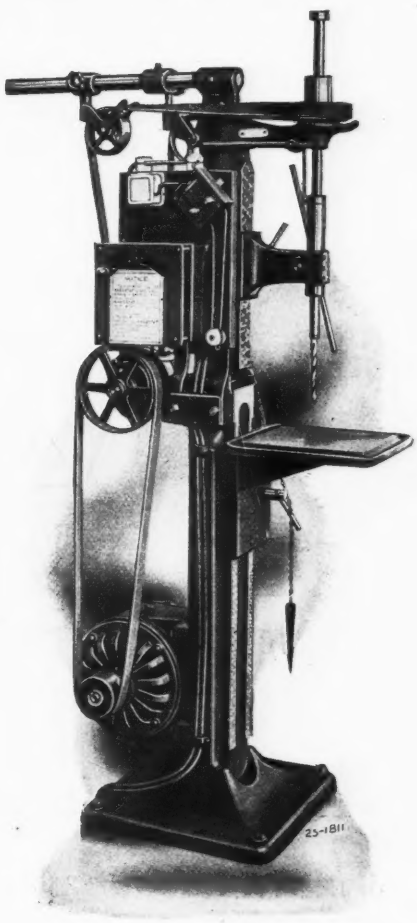
LOOK FOR THE LICENSE LABEL IN THE STEM

New York & Ohio Co.

401 North Avenue
WARREN, OHIO

Stanley-G. I. Direct Current Motors

are simple in construction, durable, economical in operation and thoroughly capable of carrying the load for which they are designed.



Type "L" Motor Driving Drill

They are, therefore, the ideal drive

Send for Motor Bulletin 245

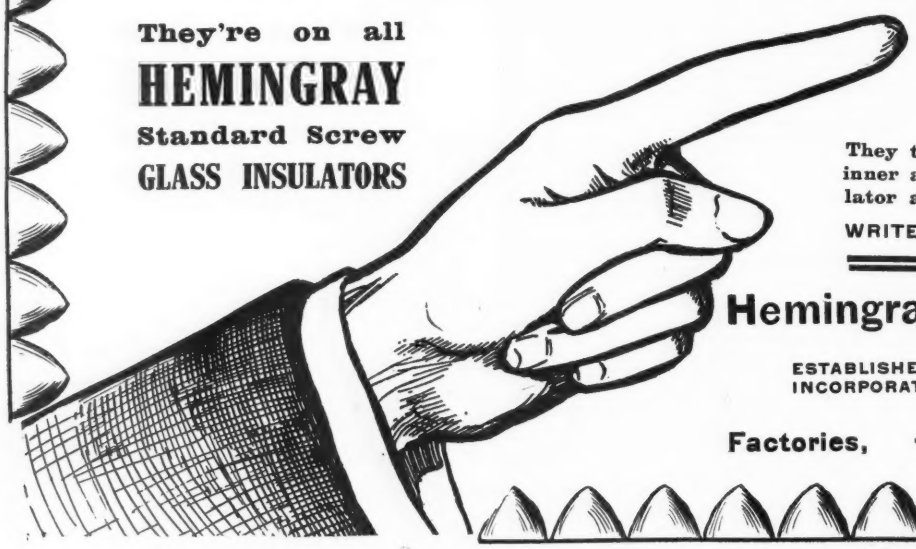
ADDRESS OUR NEAREST BRANCH OFFICE
ATLANTA, GA., Empire Building
CINCINNATI, OHIO, First National Bank Building
PHILADELPHIA, PA., North American Building
SAN FRANCISCO, CAL., 60-75 New Montgomery St.
SEATTLE, WASH., Pioneer Building
BOSTON, MASS., Oliver Building
ST. LOUIS, MO., Century Building
CHICAGO, ILL., Monadnock Block
NEW YORK, N. Y., 29 Broadway
MEXICO CITY, V. M. Braschi & Co.

Stanley-G. I. Electric Mfg. Company Pittsfield, Mass.

SEE THE TEATS ON THE PETTICOAT

No. 1 HIGH VOLTAGE
Guarantee 10,000 Volts

They're on all
HEMINGRAY
Standard Screw
GLASS INSULATORS



They take all the moisture from the inner and outer surface of the insulator and keep the pin dry . . . .

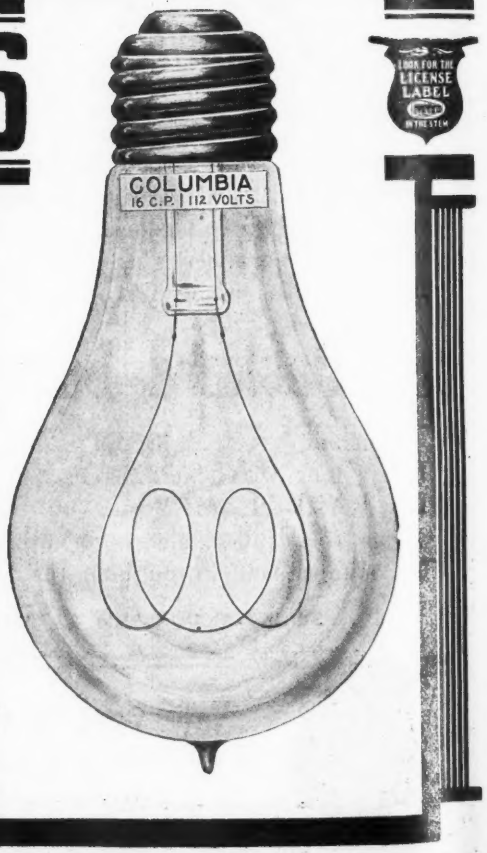
WRITE US FOR FULL INFORMATION

Hemingray Glass Company

ESTABLISHED 1848
INCORPORATED 1870 } COVINGTON, KY.

Factories, - MUNCIE, INDIANA

COLUMBIA LAMPS



ESTABLISHED IN 1889

More Light for Same Current Expenditure—
Same Light for Less Current Expenditure—

Sounds good doesn't it
The best part of it is that it's true

We respectfully invite a comparison of Columbia lamps with others, and call particular attention to the greater spherical Candle Power of the Columbia.

Send us an order for a case. Order from any Branch Office or from Factory at St. Louis.

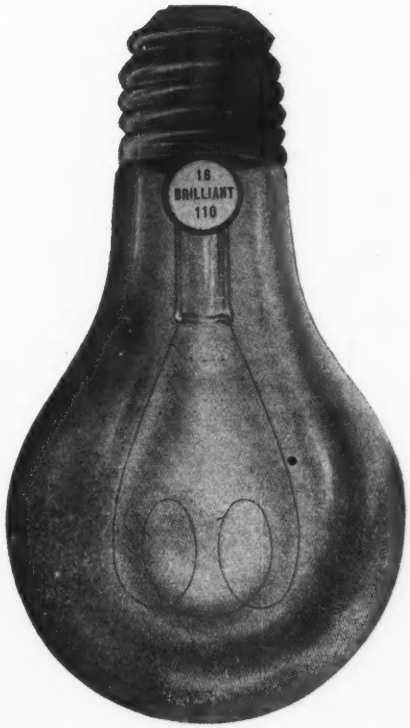
The Columbia Incandescent Lamp Company
ST. LOUIS, MO.

New York: 1311 Havemeyer Building
Philadelphia: 1227 Real Estate Trust Bldg.
Chicago: Central Electric Company
Memphis: 302 Scimitar Building
San Francisco: 105-107 Battery Street
Mexico: Monterey, Van Voorhis Hnos

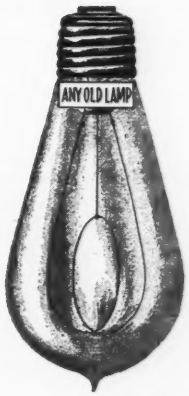
THIS

FOR THE PRICE OF

THIS



THE BRILLIANT TIPLESS LAMP



TIPLESS

TIP

A faultless tipless lamp guaranteed in every respect at a price of the backnumber kind

AND

We are fully equipped to handle all orders for high grade incandescent lamps of all voltages and candle powers.

WRITE US FOR PRICES. AGENTS WANTED EVERYWHERE

Immediate Shipment

THE BRILLIANT ELECTRIC COMPANY

66 CHESTNUT STREET

CLEVELAND, OHIO

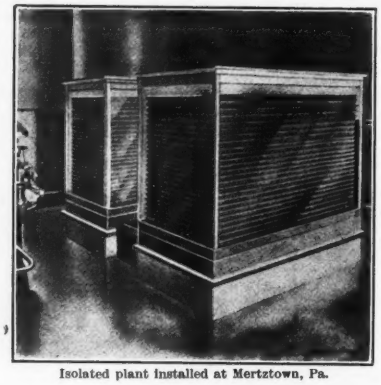
THE BATTERY
THAT PRODUCES RESULTS

BETTER AND MORE SATISFACTORY SERVICE

Very Compact—Large Contact Surface, eliminating internal resistance

THE TRAY PLATE BATTERY is known for its exceedingly Low Resistance, Economical Operation, and as a Saver of Fuel is without an equal

LARGELY INCREASED CAPITAL AND BETTER FACILITIES enable us to supply all orders promptly - - - - - -



Isolated plant installed at Mertztown, Pa.

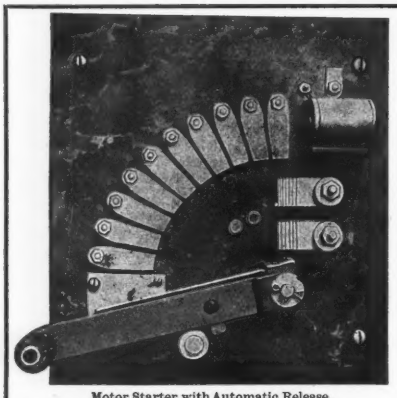
TRAY PLATE
STORAGE BATTERY

The SIMPLEST, MOST DURABLE and BEST STORAGE BATTERY MADE for Central Stations, Lighting and Power Plants, Isolated Plants, Etc.

We also manufacture an IMPROVED CELL TYPE BATTERY in All General Styles for All Purposes, including Electrical Vehicle Batteries.

SEND FOR DETAILS

TRAY PLATE BATTERY CO.
5 Frederick St., BINGHAMTON, N. Y.
NEW YORK—39 Cortlandt St.



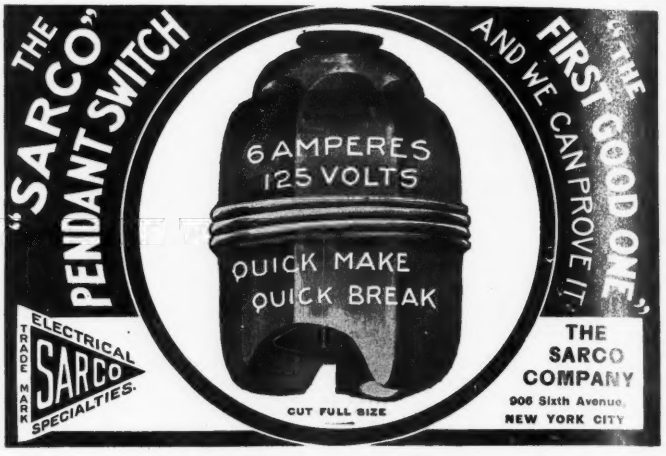
Motor Starter with Automatic Release. Manufactured under our own patents.

Motor Starters
Speed Regulators
Field Regulators

Equipped with Renewable Segments without Extra Charge

And Special Controlling Devices of all kinds. Send for catalogue and discounts

UNION ELECTRIC MFG. CO.
Milwaukee, Wis.


THE "SARCO" PENDANT SWITCH
6 AMPERES 125 VOLTS
QUICK MAKE QUICK BREAK
ELECTRICAL TRADE MARK SARCO SPECIALTIES.
CUT FULL SIZE
"THE FIRST GOOD ONE" AND WE CAN PROVE IT.
THE SARCO COMPANY
906 Sixth Avenue, NEW YORK CITY

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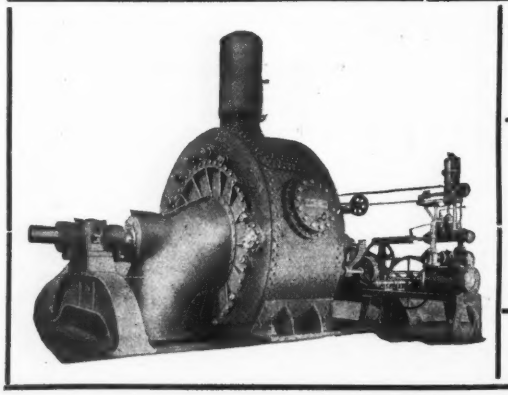


SAMSON TURBINE

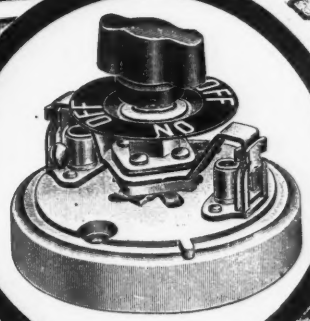
The illustration shows the large NIAGARA design, HORIZONTAL SHAFT TURBINES recently installed by us for the NIAGARA FALLS HYDRAULIC POWER & MANUFACTURING CO., Niagara Falls, N. Y. Tests conducted by competent engineers developed as follows:

Head	Gateage	Speed	H.-P.	Generator Efficiency	Turbine Efficiency
213 ft.	1-2	257 r.p.m.	1750	95 per cent	73.00 per cent
213 "	3-4	257 " "	3000	95 " "	85.60 " "
213 "	Full	257 " "	3500	95 " "	81.50 " "

These results have never been equaled by any turbine of the Horizontal Shaft Design, operating under equally HIGH HEADS. The test was made **AFTER TURBINES WERE INSTALLED**, direct coupled to Generators. Francis' weirs and formulæ for discharge were used. The original test reports on file at our offices. These turbines are all fitted with our SAMSON BALANCED GATES. Note especially the UNIFORM SPEED AT ALL GATEAGES.

JAMES LEFFEL & CO., No. 309 Lagonda St. **SPRINGFIELD, OHIO, U. S. A.**

SWITCHES OF QUALITY



"HART"

AND

"H & H" SWITCHES

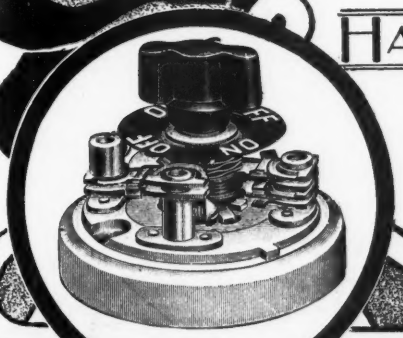
ARE THE SWITCHES OF
PERMANENT SATISFACTION

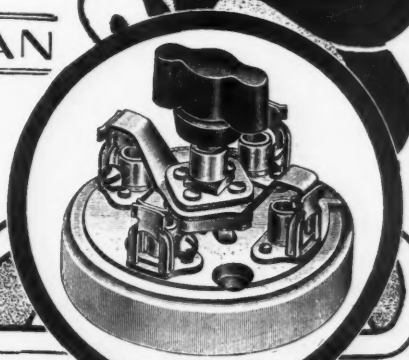
ASK ANY ELECTRICIAN

SEND FOR CATALOGUE "E"
AND LEARN ALL ABOUT THEM

THE HART AND HEGEMAN MFG. CO.

92 UNION PLACE
HARTFORD, CT.





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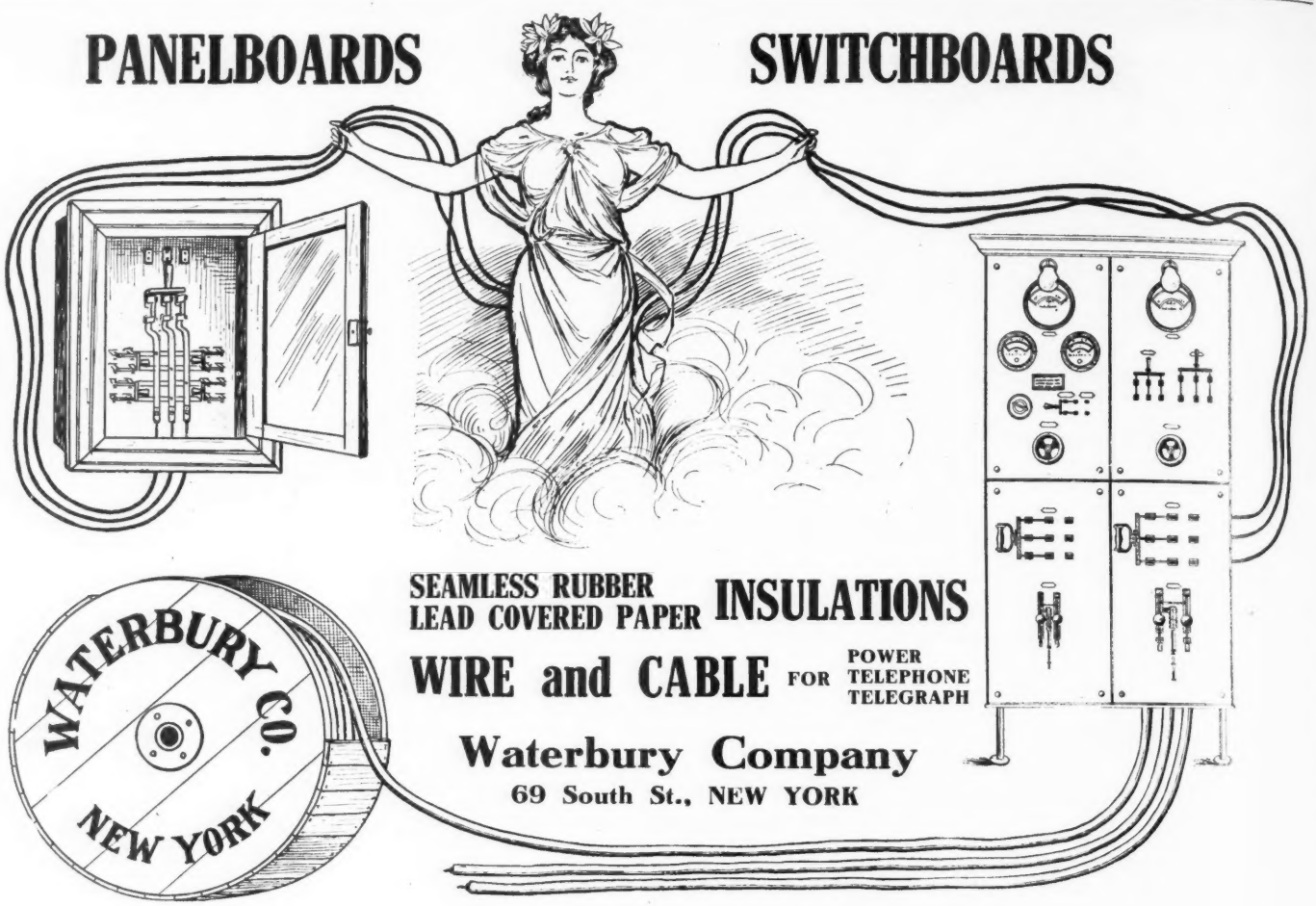


WATERBURY CO. NEW YORK

SEAMLESS RUBBER
LEAD COVERED PAPER **INSULATIONS**

WIRE and CABLE FOR POWER TELEPHONE TELEGRAPH

Waterbury Company
69 South St., NEW YORK

1906 CATALOGUE

The 1906 edition of our catalogue is printed and being distributed.
It is the most complete and valuable book we have published.
It is full of illustrations, and contains much valuable information of the latest inventions and devices known to the science, and uses of electricity.
The cipher code enables correspondence to be carried on completely by telegraph.
Every article has a code word, a number, the weight of the article, contents of standard packages, etc.
The number of the catalogue is 24.
If you do not receive a copy write for one.

OKONITE IT NEVER DISAPPOINTS

Central Electric Company,
ELECTRICAL SUPPLIES
264-266-268-270 Fifth Ave., Chicago

OKONITE IT NEVER DISAPPOINTS

No. 9136F—6 in. Diameter

HOLOPHANE PAGODA CUT GLASS BALL

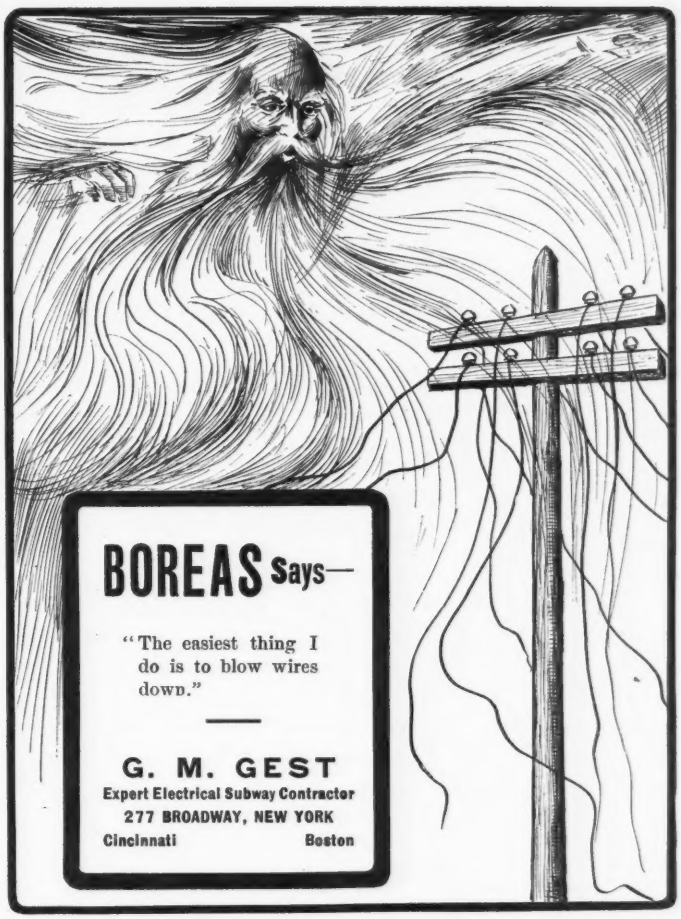
has been adopted as a standard by the U. S. Government for all Post Offices and Court Houses in the Country. We have various styles in cutting.

WRITE FOR OUR CATALOGUE

HOLOPHANE GLASS COMPANY

SALES DEPT.

227 Fulton Street, NEW YORK



THE RAIL JOINT CO.

GENERAL OFFICES

29 West 34th Street, New York City

Makers of

CONTINUOUS, WEBER AND WOLHAUPTER

RAIL JOINTS

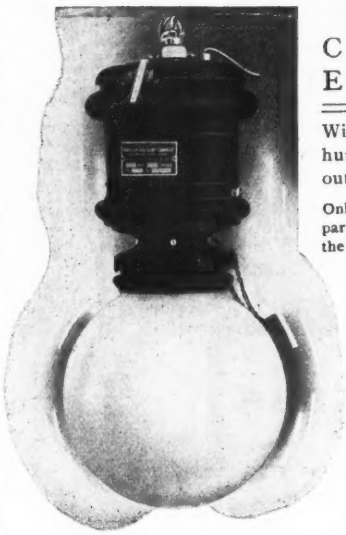
Protected by United States Patents

Branch Selling Agencies

BALTIMORE, MD., Union Trust Bldg.
BOSTON, MASS., John Hancock Bldg.
CHICAGO, ILL., Monadnock Bldg.
DENVER, COLO., Equitable Bldg.
SEATTLE, WASH., Washington Bldg.
ST. LOUIS, MO., Commonwealth Trust. Bldg.
ST. PAUL, MINN., Pioneer Press Bldg.

Arc Lamps

DIRECT CURRENT ENCLOSED



Will operate two hundred hours without trimming :: ::

Only five parts and every part accessible without the use of any tools

SELF-LOCKING SWITCH

Not affected by smoke, dust or rough usage :: ::

Our catalogue tells all

The ideal for factories, foundries, and machine shops

American Arc Lamp Company

Kalamazoo ═══ Michigan

WHEN ANSWERING ADVERTISERS PLEASE MENTION THIS PAPER.

AN OUNCE OF PREVENTION

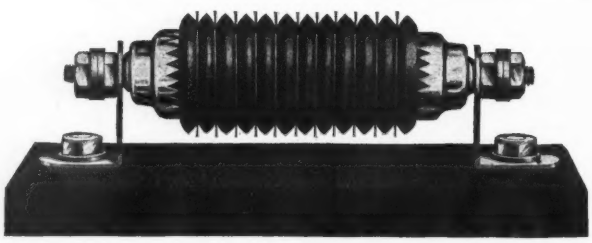
IS WORTH

A POUND OF CURE

WHEN YOU USE

SHAW NON-ARCING LIGHTNING ARRESTERS

You Get a Pound of Prevention Worth Its Weight in Gold



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ADJUSTERS, INCANDESCENT LAMPS
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AIR-COMPRESSORS
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National Electric Co.
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Stanley & Patterson
W. R. Ostrander & Co.
Wesco Supply Co.

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BELT DRESSING
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Bissell Co., The F.

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Eastern Carbon Works
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Wirt Electric Co.

BUSHINGS
Bossert Electric Construction Co.

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Bissell Co., The F.
Johns-Manville Co., H. W.

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Standard Underground Cable Co.

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Union Electric Mfg. Co.
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Simplex Electric Heating Co.
Union Electric Mfg. Co.
Wirt Electric Co.

CORD AND ROPE
Samson Cordage Works

COUPLINGS
Cutler-Hammer Clutch Co.

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Doubleday-Hill Electric Co.
Klein & Son, Mathias

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Dustin Co., Chas.
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Jandus & Leist Electric Co.
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Clement, Edward E.
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Darlington, F. W.
Dodge & Day
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Foster, Horatio A.
Gunn, Richard & Co.
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Hanchett, George T.
Humphrey, Henry H.
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Kelly Engineering Co., John F.
Kitfield, Edward H.
Knowles, Edward R.
Lyndon, Lamar
M'Glehan & Co., C. H.
Mershon, Ralph D.
Muralt & Co.
New England Engineering Co.
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Stanton, Le Roy W.
Townsend, Fitzhugh
White & Co., J. G.
Wilmerding, C. H.

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Lawrence Electric Co., F. D.

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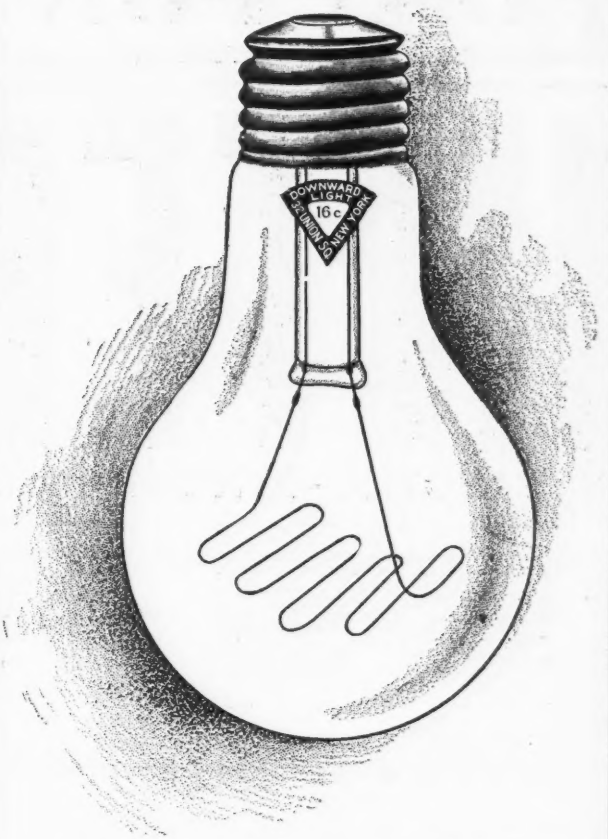
128% MORE LIGHT



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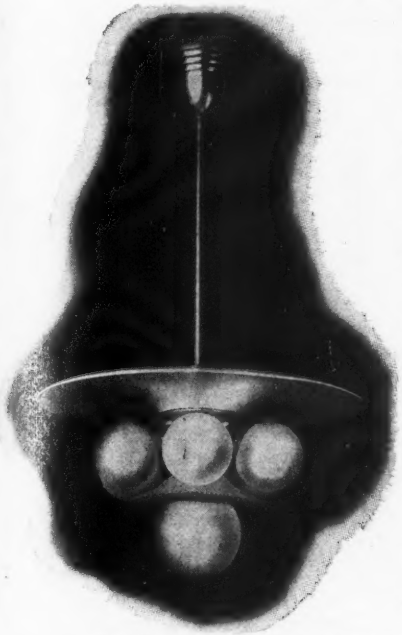

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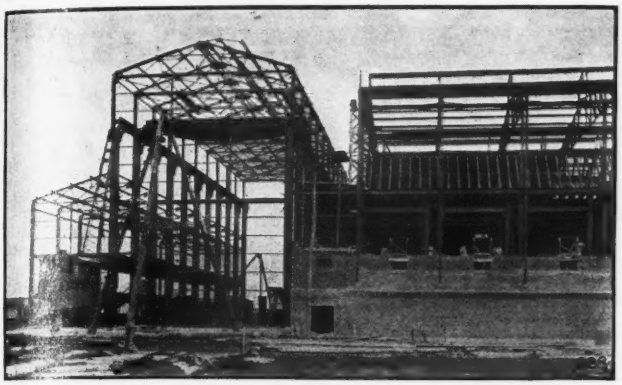

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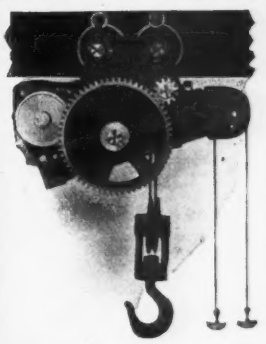

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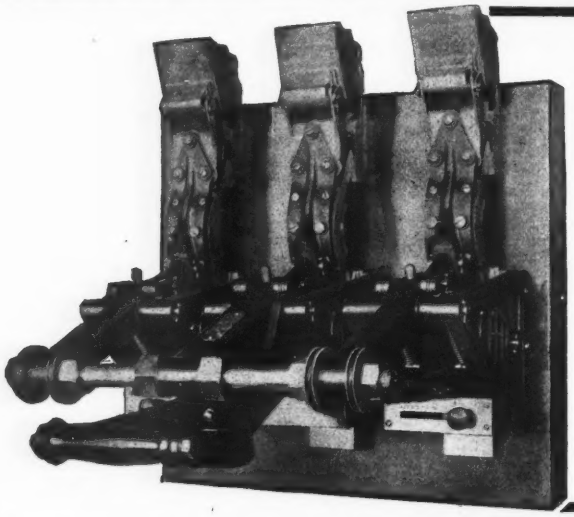

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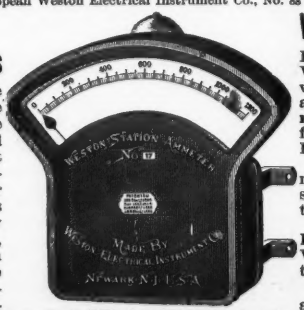

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List of Electrical Patents Issued Last Week

(Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.)

ISSUED NOVEMBER 28, 1905.

805,439 Lightning arrester; A. J. Berry, Marion, Ohio.

805,448 Magnetic separator for ores; H. F. Campbell, Melrose, Mass.

805,499 Electric drill; S. D. Stoycheff, Toledo, Ohio.

805,501-502 Method of producing chemicals in electric furnaces; E. R. Taylor, Penn Yan, N. Y.

805,505 Automatic regulator for electric circuits; M. Waddell, New York, N. Y.

805,509 Electric cutout; W. P. Wright, Blandinsville, Ill.

805,547 Armature for electrical machines; W. T. Hensley, Bound Brook, N. J.

805,557 Electric-current generator; William Kaisling, Chicago, Ill.

805,568 Trolley base; H. R. Lockhart, Westmount, Canada.

805,572 Trolley wheel; A. H. Mathesius, Brooklyn, N. Y.

805,574 Electric gas-lighter; Joseph Mlada, Manitowoc, Wis.

805,619 Electric signaling system; W. S. and A. S. Aungst, Alliance, Ohio.

(Continued on page 52.)

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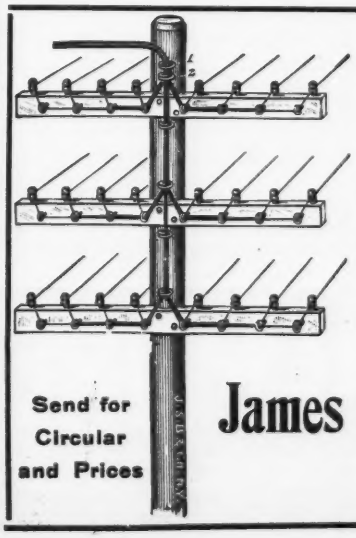

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PATENTS.

(Continued from page 51.)

805,694 Method of electrostatic separation; P. H. Wynne, Boston, Mass.

805,714 Visible and audible signal; John L. Creveling, New York, N. Y.

805,724 Wire-cutting mechanism; N. S. Harter, Chicago, Ill.

805,725 Controlling device for electric generators; Moritz von Hoor, Friederich Reinitz and Leopold Stark, Budapest, Austria-Hungary.

805,735 Rear-end contact telegraph key; S. B. Lefley, Florinel, Pa.

805,783 Electric furnace; J. S. Dorian, Niagara Falls, N. Y.

805,788 Electric strain insulator; S. L. Foster, San Francisco, Cal.

805,795 X-ray tube; J. O. Heinze, Jr., Lowell, Mass.

805,827 Railroad signal circuit; E. W. Vogel, Chicago, Ill.

805,854 Magnetic ore separator; Eric Hedburg, Joplin, Mo.

805,856 Block system for railroads; A. N. Ireland and J. T. Reese, Sioux City, Iowa.

805,874 Automatic fire-extinguisher system; J. G. Nolen, Chicago, Ill., and J. D. Nolen, Toledo, Ohio.

(Continued on page 54.)

PATENTS—TRADE-MARKS

James Hamilton, M. E., LL. B.

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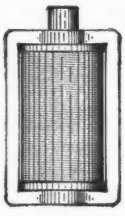

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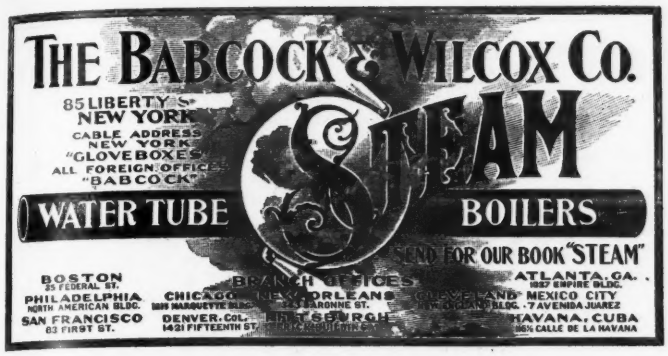
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805,879 Illuminating device; Adolph Richter, New York, N. Y.

805,901 Telephone exchange system; H. T. Cedegren, Stockholm, Sweden.

805,952 Electrical muscular exercising machine; R. O. Hammond, Buffalo, N. Y.

805,968 Junction box; E. T. Greenfield, Monticello, N. Y.

805,996 Journal box; J. G. Pontious, Bon Ami, La.

806,009 Automatic motor-starting resistance; Ralph Scott, Wilkesbarre, Pa.

806,017 Ignition plug; C. F. Splitdorf, New York, N. Y.

806,018 Electromagnetic relay or sounder; T. M. St. John, New York, N. Y.

806,035 Electric signaling and electropneumatic train-control system; J. A. Whyte, Toronto, Canada.

806,039 Electric heater for oil wells; J. E. Williamson and C. E. Collins, Allegheny, Pa.

806,052 Receiver for wireless telegraphy; H. S. Blackmore, Mount Vernon, N. Y.

806,067 Electrical signaling mechanism; D. H. Coker, Piedmont, Ala.

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12,413 Mechanism for recording or registering the maximum movement of any mechanism; Llewelyn B. Atkinson, London, England.

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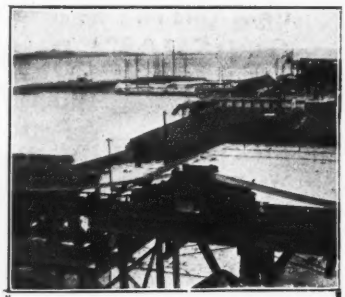

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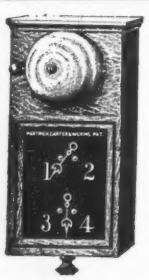

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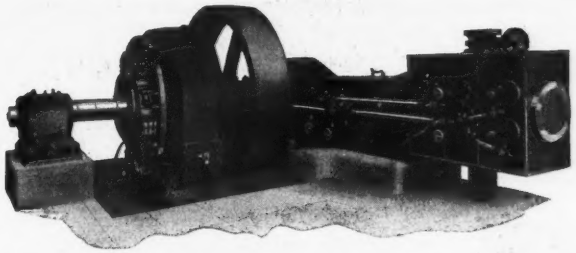

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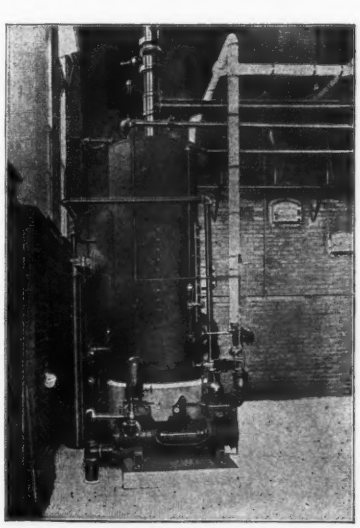

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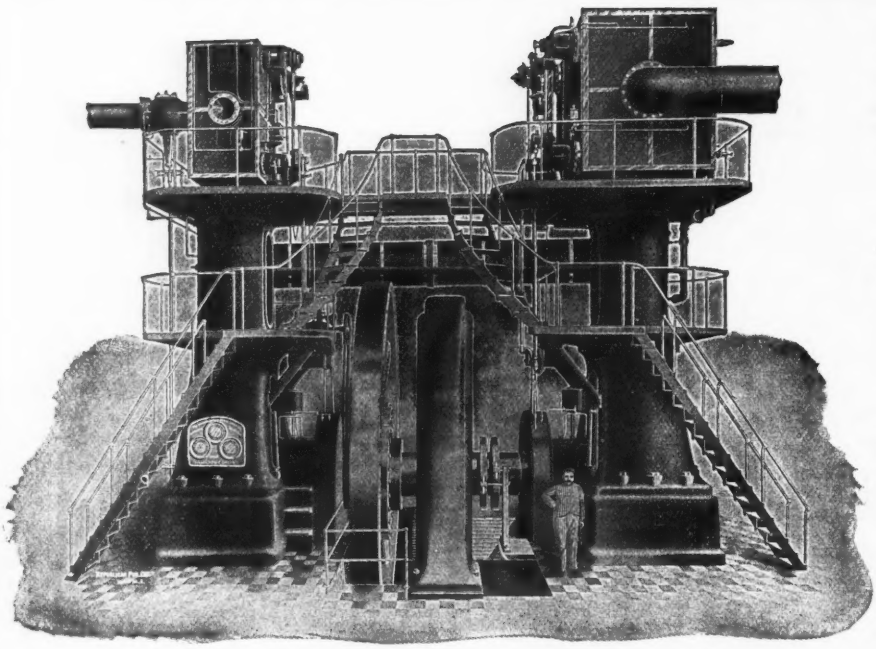

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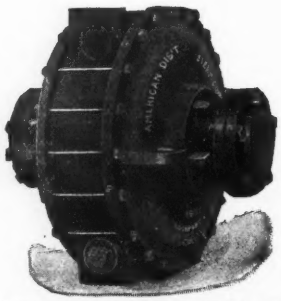

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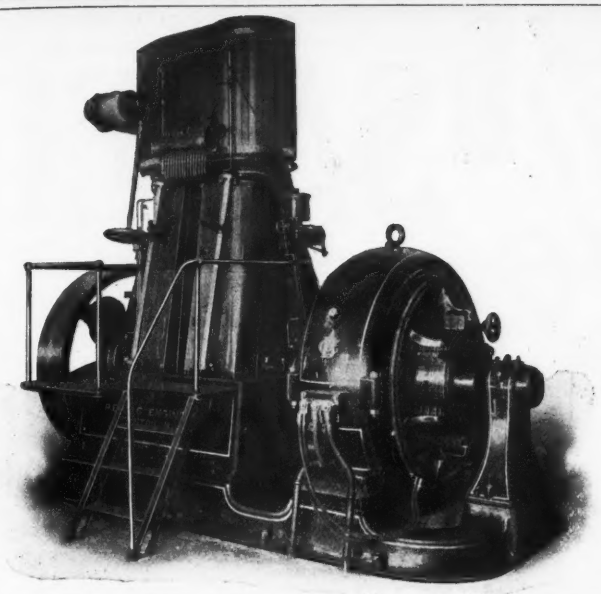

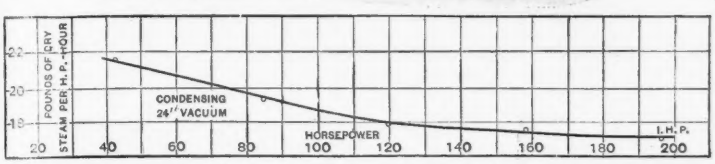

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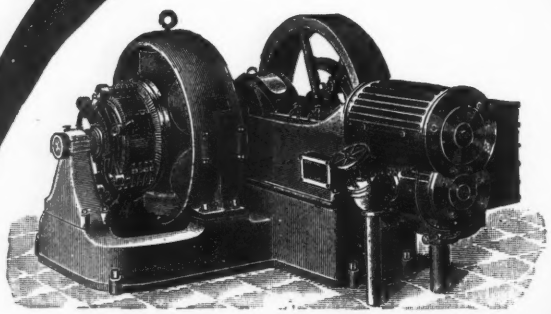

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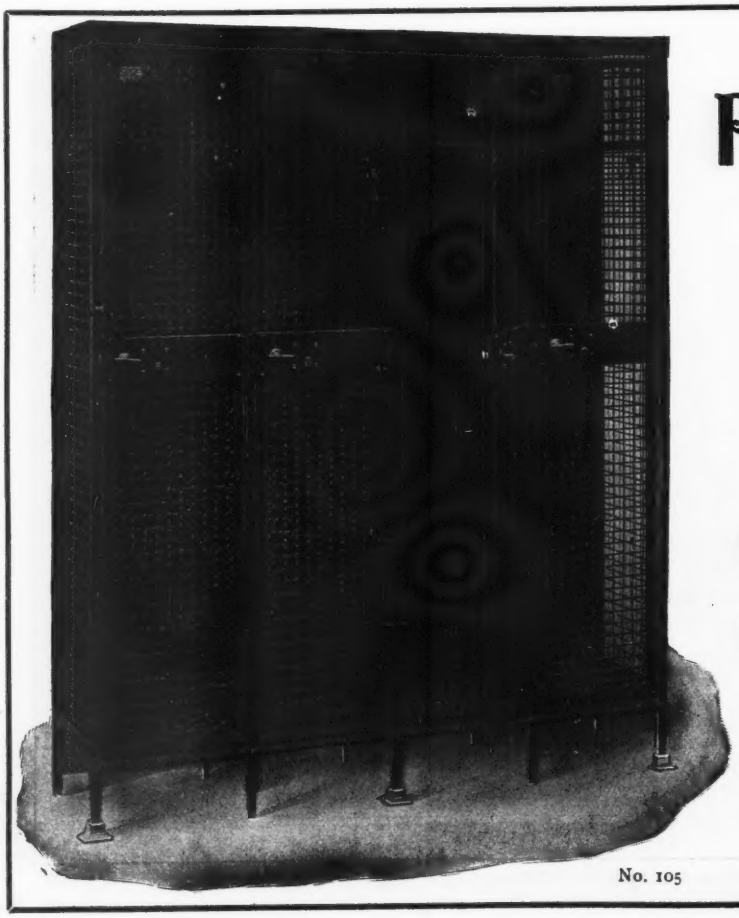

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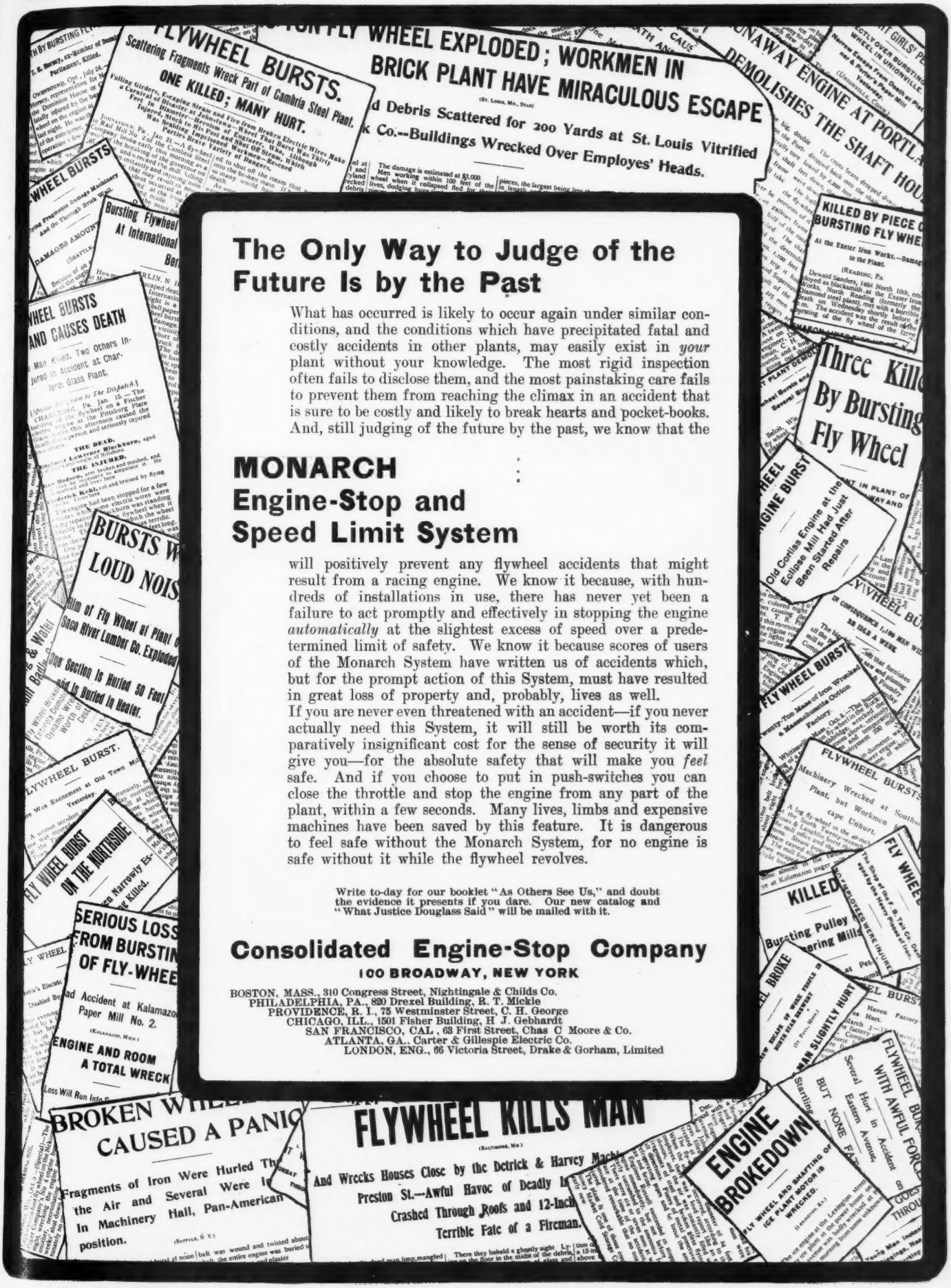
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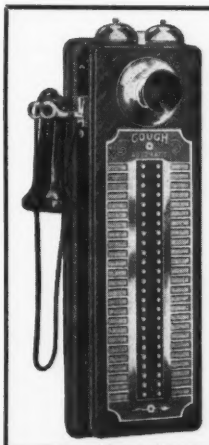

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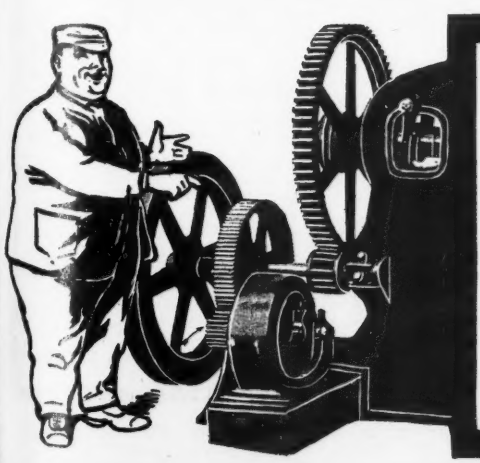

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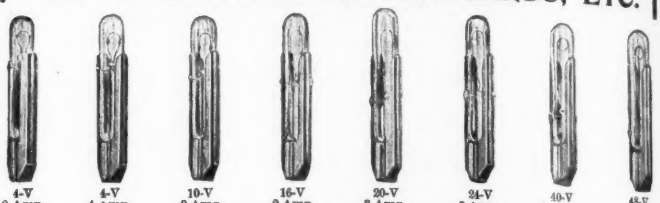

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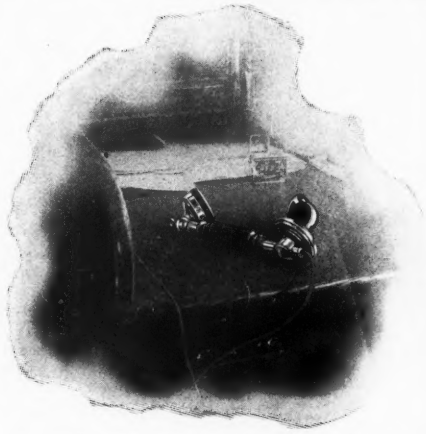

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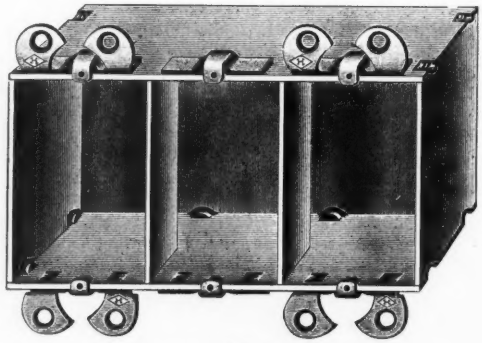

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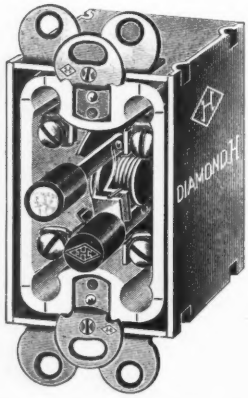

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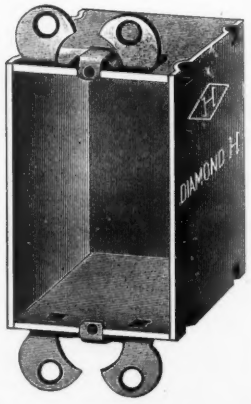

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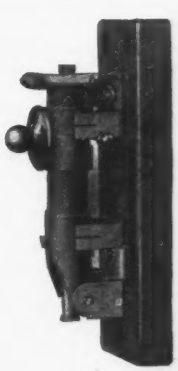

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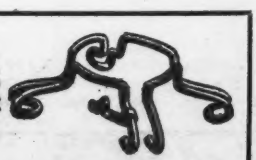

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